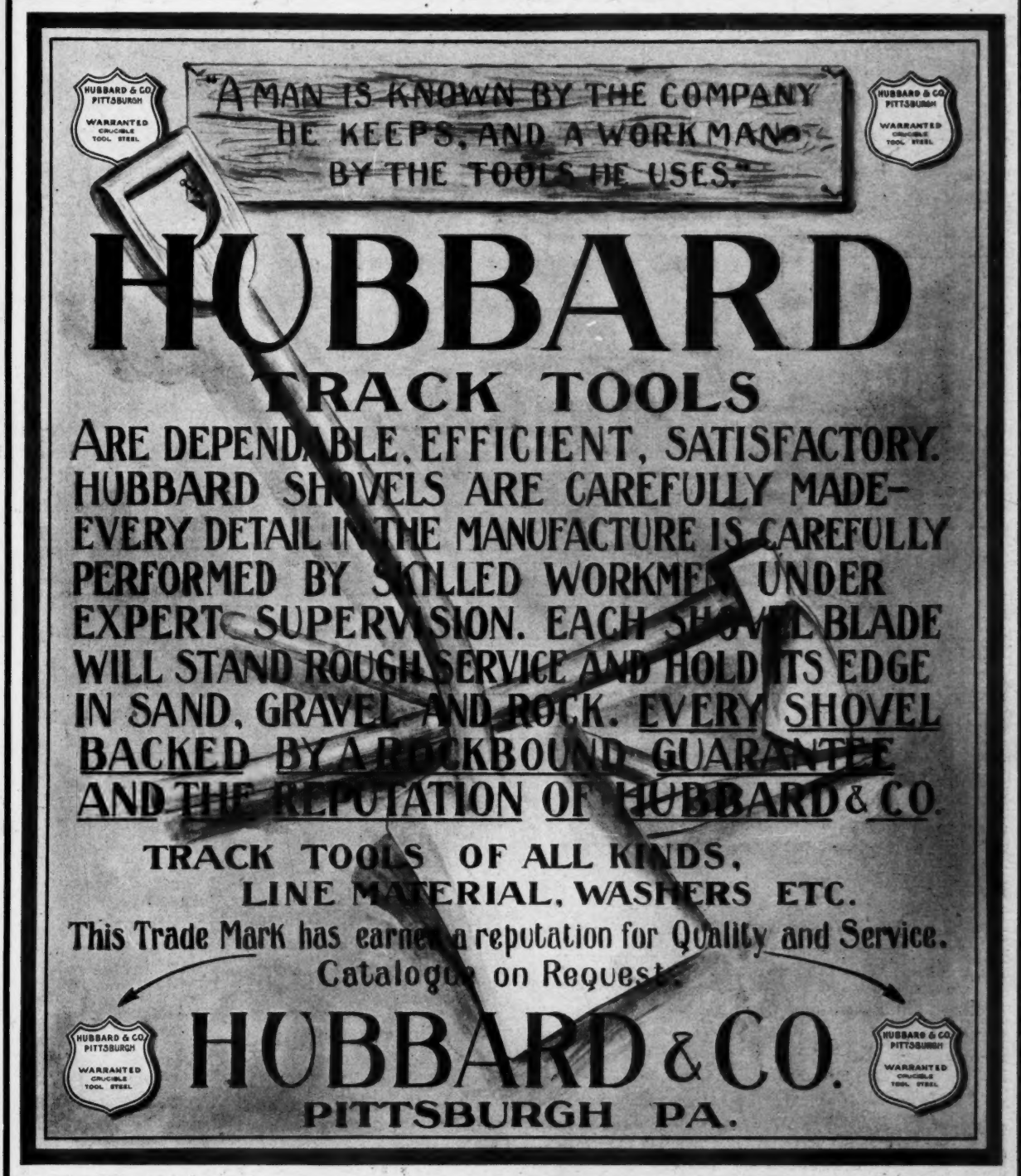
RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

BRIDGES - BUILDINGS - CONTRACTING - SIGNALING - TRACK

New Series, Vol. VIII
Old Series, Vol. XXVII

Chicago OCTOBER, 1912 *New York*

No. 10


HUBBARD & CO. PITTSBURGH WARRANTED CRUCIBLE TOOL STEEL
"A MAN IS KNOWN BY THE COMPANY HE KEEPS, AND A WORKMAN BY THE TOOLS HE USES."
HUBBARD
TRACK TOOLS
ARE DEPENDABLE, EFFICIENT, SATISFACTORY.
HUBBARD SHOVELS ARE CAREFULLY MADE—
EVERY DETAIL IN THE MANUFACTURE IS CAREFULLY
PERFORMED BY SKILLED WORKMEN UNDER
EXPERT SUPERVISION. EACH SHOVEL BLADE
WILL STAND ROUGH SERVICE AND HOLD ITS EDGE
IN SAND, GRAVEL AND ROCK. EVERY SHOVEL
BACKED BY A ROCKBOUND GUARANTEE
AND THE REPUTATION OF HUBBARD & CO.
TRACK TOOLS OF ALL KINDS,
LINE MATERIAL, WASHERS ETC.
This Trade Mark has earned a reputation for Quality and Service.
Catalogue on Request.
HUBBARD & CO.
PITTSBURGH PA.

This Journal has a larger circulation than any other, in the Maintenance of Way Departments of the Railways of the United States and Canada

Alphabetical Index to Advertisers, Page 20. Classified Index to Advertisements, Page 18.

HUBBARD TRACK TOOLS

Are the result of many years' experience. "Proved Best by Every Test."

Our track chisels are made from the best crucible tool steel that can be produced for this purpose. Every track tool we make is sold under an absolute guarantee. Our track shovels are standard on many roads. Our locomotive scoops are known to every fireman.

HUBBARD & CO.

WRITE FOR CATALOG **PITTSBURGH, PA.**

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TRADE MARK.

Insulated Wires and Cables

will continue giving satisfactory service long after their purchase has been forgotten—made in but *one* grade—the *best*.

Look for the Ridge

A distinguishing mark on *genuine* OKONITE insulation consists of a single ridge running the entire length of the wire.

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252 Broadway, New York

Central Electric Company,
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85% MAGNESIA
LOCOMOTIVE
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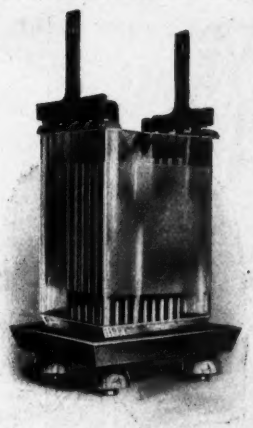
THE UNITED STATES LIGHT AND HEATING CO.

(Formerly National)

Storage Batteries For Signal Service

U-S-L batteries discharge only when the signal circuit is closed. Although the service be extremely intermittent they retain their capacity—no energy being dissipated uselessly by internal discharge. This desirable feature is secured by our advanced methods of manufacture and the absolute purity of our raw materials.



The U. S. Light & Heating Co.

GENERAL OFFICES: 30 Church Street, New York
FACTORY: Niagara Falls, New York

BRANCH OFFICES AND SERVICE STATIONS:

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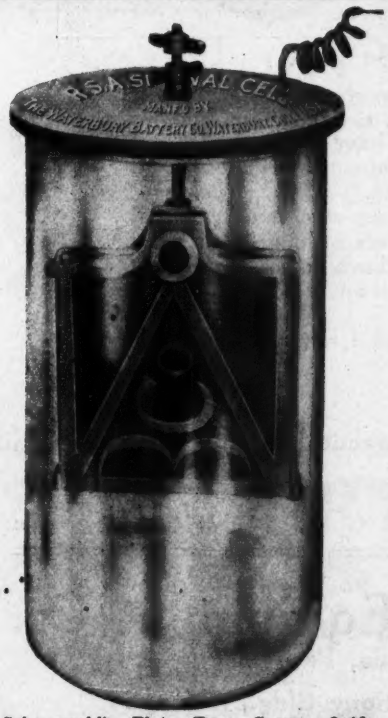


Schoenmehl's Plate Type Copper Oxide Cell, Equipped as per R. S. A. Standards, Heat Resisting Glass Jar.

Chicago Sales Office
BRYANT ZINC CO., 600 Orleans St.

A Signal Success

Schoenmehl's R.S.A. Cell

is a result of the combination of

1. The best materials that can be secured.
2. The knowledge, acquired by many years of experience, of how to make a battery.
3. The inspiration of a long record of success in filling signaling requirements.

The logical conclusion, therefore, is that what you get out of the Schoenmehl cell will be entirely in keeping.

And so it is. This conclusion is supported by service records. Why not prove it to your own satisfaction? Install some Schoenmehl batteries and let them show what they can do.

There is a clean saving from the very start; you will reduce maintenance costs to the minimum; and you will have the knowledge when using this type of cell that you have taken the very best step possible to secure efficiency in the operation of your signals.

Every cell is guaranteed for full 400 ampere hours. We have put them in. You can get them out.

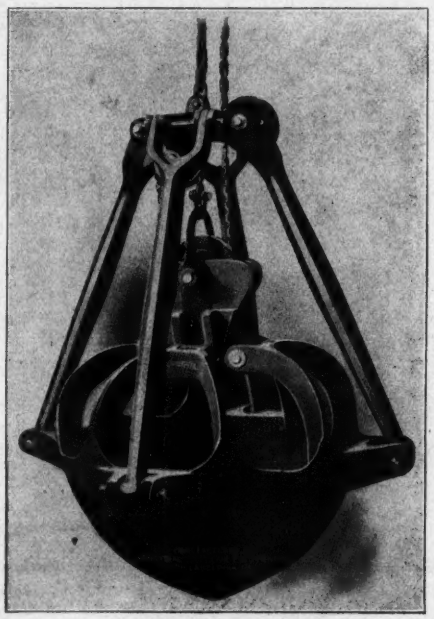
The Cell that Sells

Waterbury Battery Company

Waterbury, Conn.

New York Sales Office
BRYANT ZINC CO., 50 Church St.

THE BUCKET
AND WHAT THE OWNER SAYS



Gentlemen:

In regard to the work done by "Rickards Orange Peel Bucket," which we purchased of you, would say that it was highly satisfactory in every particular.

We used this bucket from a small derrick-scow on a submerged ledge, that we were blowing out of the head of the Thames River at Norwich, Conn. In order to get on this ledge we were forced to go under a low bridge about 30 feet high; in fact, we had to work directly under the bridge most of the time. This fact made it necessary for us to use a small derrick and therefore a small bucket.

We drilled and blew this rock, but found much to our disgust that it would not open up in any kind of shape, but would first crumble and crack in all directions. After blowing it a number of times we went to work with an Orange Peel, but found that the design of this bucket in so small a size interfered with its getting a proper hold on the stone; in fact, we found a diver would pick up into a scale-box more stone in a day than we could dig.

About that time I heard of your bucket, and as soon as I saw it, I knew it would dig rock or bust, so my people bought it, as you know, and we consider it the best bucket for this line of work we have ever seen. After buying the Rickards Bucket we soon finished our contract, and had we had it at first we would have been a good many dollars in.

In regard to the strength of this bucket, would say that it is O. K. I have often seen it come out of the water fast to a piece of ledge that it had pulled out, and would weigh easily four tons, and have sometimes seen it stick the hoister before it would let go. In fact, given any kind of a chance, it can't let go.

If this letter is of any use to you, why use it, for I have great faith in your bucket after the bad job it pulled us through.

(Name on application)

If you want to know more about the most practical "Orange Peel Bucket" write us.

The Industrial Supply & Equipment Co.

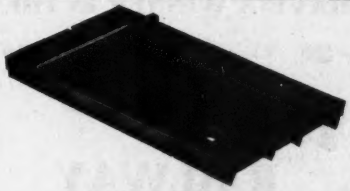
407 Sansom Street, Philadelphia, Pa.

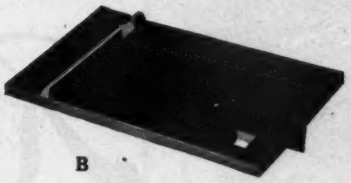
Agents—J. E. CHISHOLM, 350-55 Old Colony Bldg., Chicago
FRANK D. MOFFET & CO., New York and Boston

Our guarantee, "more yards per day under like conditions than with any other bucket."

ROLLED STEEL SHOULDER TIE PLATES

Flanged and Flat Bottom





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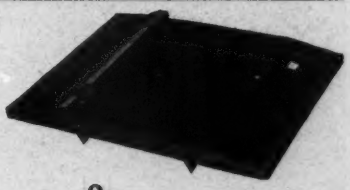

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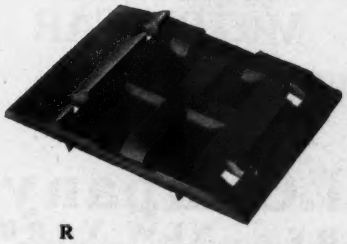
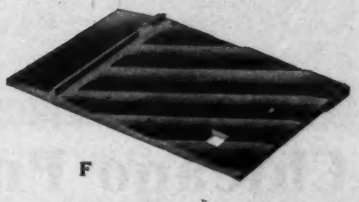


R

Our Catalog Describes 20 Types of Tie Plates.

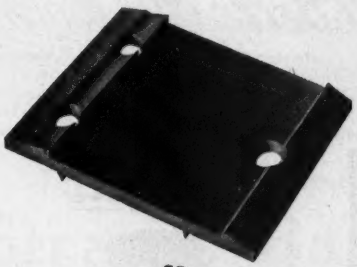


F

SCREW SPIKE TIE PLATES

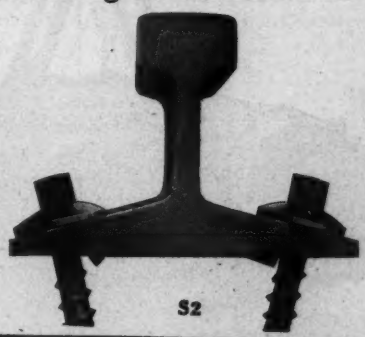
Six Different Types

To Meet the Requirements of American Engineering Conditions



S2

This Inclined Screw Spike Plate is designed to furnish *wide Surface Contact* between the head of the Screw Spike, Rail and Tie Plate. Has but one shoulder, to permit easy removal of rail.



S2

THE HART STEEL COMPANY

ELYRIA, OHIO

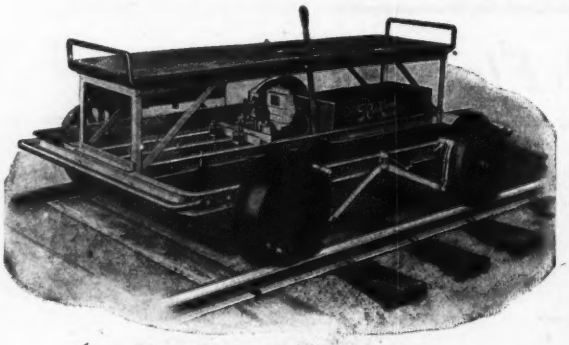
Plates Manufactured by the Elyria Iron & Steel Co.

SALES AGENCIES

NEW YORK—H. W. Davis, U. S. Express Building
ATLANTA—J. M. Van Harlingen, Candler Building
CHICAGO—G. S. Wood, Great Northern Building
SAN FRANCISCO—Western Ry. & Mill Supply Co., Monadnock Building

WE HAD IT ALL FIGURED OUT

We Knew That if we took the well-known *"Rockford"* Engine, and mounted it in a welded steel channel frame and eliminated dry cells, spark coil and timer, substituting therefor Magneto Ignition, and eliminated chain drive to cam shaft, substituting therefor direct drive through spiral gears, enclosed and running in oil



No. 4 Rockford Magneto Car

WE WOULD HAVE A WINNER IN THE

"Rockford" RAILWAY MOTOR CAR

SEND FOR CATALOGUE NO. 40
AND CIRCULARS NOS. 103 - 104 - 105 - 116

Chicago Pneumatic Tool Company

CHICAGO 1010 Fisher Bldg. BRANCHES EVERYWHERE NEW YORK 50 Church St.

Kalamazoo Hand Cars

are equipped with the Kalamazoo Improved Reinforced Pressed Steel Wheel, giving 50 to 100 per cent greater wear than any other wheel of similar design or weight on the market. The car has stout gallows frame, thoroughly trussed, has taper wheel and pinion fits on axles, machine cut gears, flexible steady box and double acting brake.

16 Different Styles, Standard or Special

Catalogue of Track and Railway Supplies on Request

Kalamazoo Railway Supply Co.
Kalamazoo, Mich.

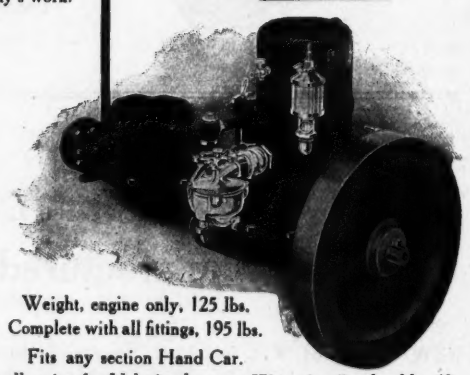
Western Representative: **Universal Railway Supply Co., Chicago**

Make Your *Hand Car* ---into a *Motor Car*

You can easily install a *Belle Isle Motor*

on your hand car in a couple of hours. The engine will propel any load your car will carry. Save your laborer's strength for real maintenance work, instead of making him pump a back-breaking, slow-running hand car. With a gasoline car you will ***get there*** quicker—easier. You will have ***more time,*** your laborers will have ***more strength*** and ***more inclination*** to do a full day's work.

4 to 5 H. P.
= 20 Man Power



Weight, engine only, 125 lbs.
Complete with all fittings, 195 lbs.

Fits any section Hand Car.
Smaller size for Velocipedes. Write for Catalog No. 40

CONCRETE FORM & ENGINE CO.
502 Wayne County Bank DETROIT, MICH.

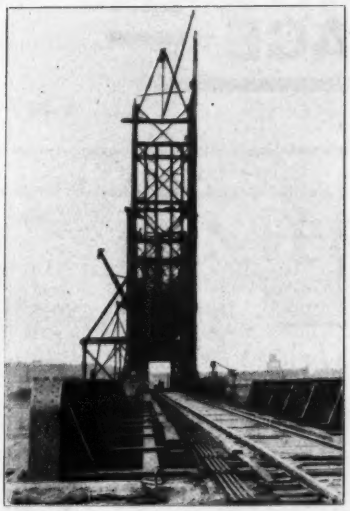
The

Strauss Bascule Bridge

Company

Engineers—Specialists in Movable Bridges

104 So. Michigan Ave., CHICAGO



Erection of Bascule Span—Open Position

Completed Structure Before Removal of Old Abutment

The above views indicate how a

Strauss Bascule

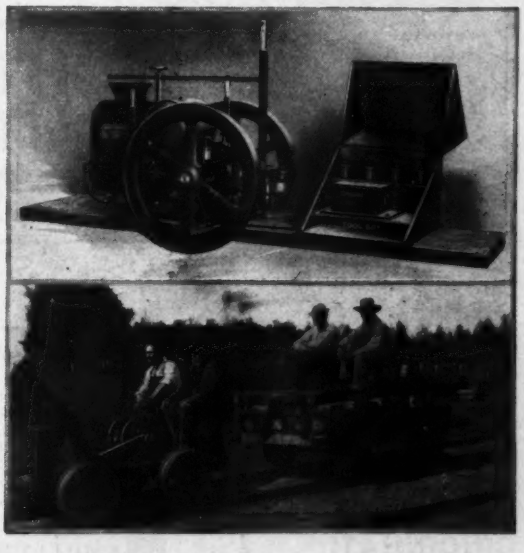
replaced an old swing bridge
WITHOUT INTERRUPTING TRAFFIC
or CHANGING ALIGNMENT
DURING ERECTION

The **longest** and **heaviest** bascule bridges **in the world** are **Strauss designs,** viz: a 235 ft. single leaf span for B. & O. R. R., and a 336 ft. double leaf span for the C. P. R.

Write to us for further information, sketches and estimates

Fairmont Motor Cars

THE FAIRMONT WAY

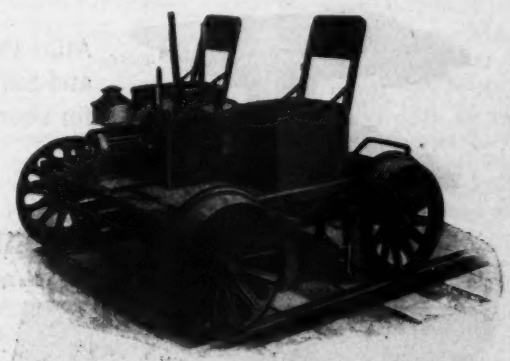


UP HILL TEN MILES PER HOUR

"Reversible."—Runs equally well either way without turning car.

Sliding Base.—Do not push your car to start it but slide your engine back into the belt.

Fully Equipped Engine.—Can be placed on an ordinary hand car in two hours. Great Power, Light Weight. Absolutely the only Engine that made good every day last winter on the Northern roads. Guaranteed 3 years. One-third less gasoline pulls a bigger load, runs faster than any other car of greater rated horse power.

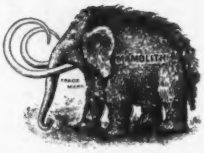


Our Strictly New Roadmaster's Car that will go in any Baggage Car. Reversible seats, and light weight. Runs either way without turning car. It just can't be beat.

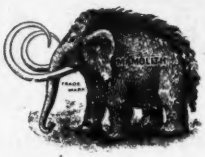
Write us immediately for all information, including our easy payment plan. We have a lot more to tell you.

FAIRMONT MACHINE CO.

FAIRMONT, MINN.



MAMOLITH



THE RIGHT PAINT IN THE RIGHT PLACE

MAMOLITH——The Railroad's GUARANTEE.

MAMOLITH——The Brand prepared by a SPECIALIST, for a SPECIAL MARKET.

MAMOLITH——The Symbol of equal strength to the "STERLING" mark on Silver.

MAMOLITH——The Sign of the ONLY EXCLUSIVE Railway Paint Manufacturer in the World.

CINCINNATI OHIO

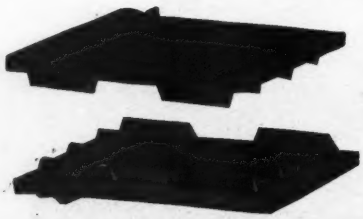
THE MAMOLITH CARBON PAINT CO.

A. B. BURTIS
President and General Manager

OAKLEY OHIO

ATLAS RAIL JOINTS, TIE PLATES AND BRACES

ATLAS SWITCH STANDS AND CAR MOVERS



Top and Bottom View of Atlas Tie Plate

Atlas Primer and Surfacer for Your Cars

Atlas Standard Suspended Joint

Atlas Compromise and Insulated Joints

Made either of Atlas Special Malleable Iron or of High Grade CAST STEEL

Atlas Compromise or Step Joint
Made to Fit any Combination of Rails, Tee or Girder.

Made Either Suspended or Supported.

Atlas Insulated Joint

ATLAS RAILWAY SUPPLY COMPANY, 1523-7 Manhattan Building Phone Harrison 2900 CHICAGO

Write for Circular "M"

R. Seelig & Son

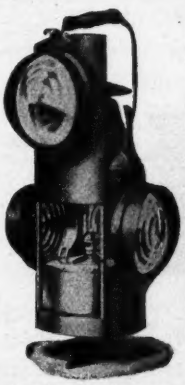
Manufacturers of

Engineering and Surveying Instruments

Instruments Carefully Repaired and Adjusted

Send for Catalogue

227 N. Fifth Ave. CHICAGO



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CHIMNEYLESS BURNERS

for one day and long-burning service

30 YEARS' EXPERIENCE

New and specially equipped factory enables us to fill large orders promptly and at fair prices.

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Round Body Steel Switch Lantern

TUBULAR POLES
IRON OR STEEL

for Signal, Electric Railway and Lighting Service. Trolley Brackets Plain and Ornamental for Wood and Iron Poles. Line Material. Mast Arms.

Let us estimate on your requirements

ELECTRIC RAILWAY EQUIPMENT CO.

General Office, 2900 Cormany Avenue

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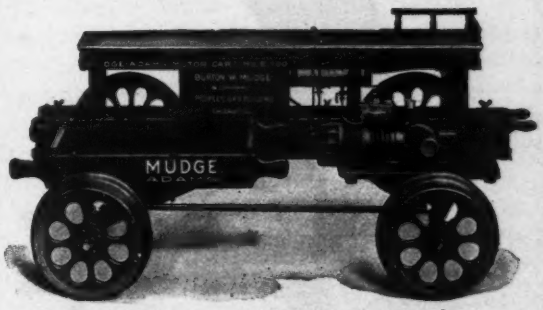
The Railway Pays for *Your* Motor Car Whether *You* Get It or Not



Save time by using the Mudge-Adams Motor Car "The Car That's Easy to Buy"

The old saying that "time is money" is as true today as when it was first uttered. Perhaps it is more so because there has never been an age when competition for brains and business was as keen as now. The rewards for those who go to the top, however, adequately compensate them for the effort exerted to gain advancement.

What are *you* doing to secure preferment?

The suggestion is here presented to those railway men whose duties require them to cover a given territory daily, to *"make a Motor Car a stepping-stone for advancement."*

The saving of time effected by the use of a Motor Car is sufficient to pay for it in a reasonable length of time. This fact has been demonstrated many times. Take the man who earns $3.00 per day. If the use of a Motor Car can save for him but an hour and a half per day, the saving will repay the original cost of the Mudge-Adams Motor Car in about eight months. This is one example proving that "time is money."

The man who figures out his work and finds a Motor Car will save money for his company and presents the facts to his superior officer is "getting out of the rut."

A roadmaster bought a Motor Car with *his own money* and made such a record on his district that he was promoted from roadmaster to division superintendent in one step. In fact, many men have purchased Motor Cars with their own money and have found that the ownership of the car has been of advantage to them.

For the benefit of the large class of men who need Motor Cars and want to buy them with their own funds, we have an easy monthly payment plan which permits the use of the car while you are paying for it.

The Mudge-Adams is the lightest four-horsepower car made and weighs less than most cars developing only two horsepower. Every working part is easily accessible, and it is so simple that it is practically trouble proof. One man can handle our car on and off the rails (in four seconds) and it easily carries three men, tools and supplies.

BURTON W. MUDGE & COMPANY, 1039 Peoples Gas Building, Chicago: I do not want to overlook any opportunity, so send me the literature about "The Car That's Easy to Buy."

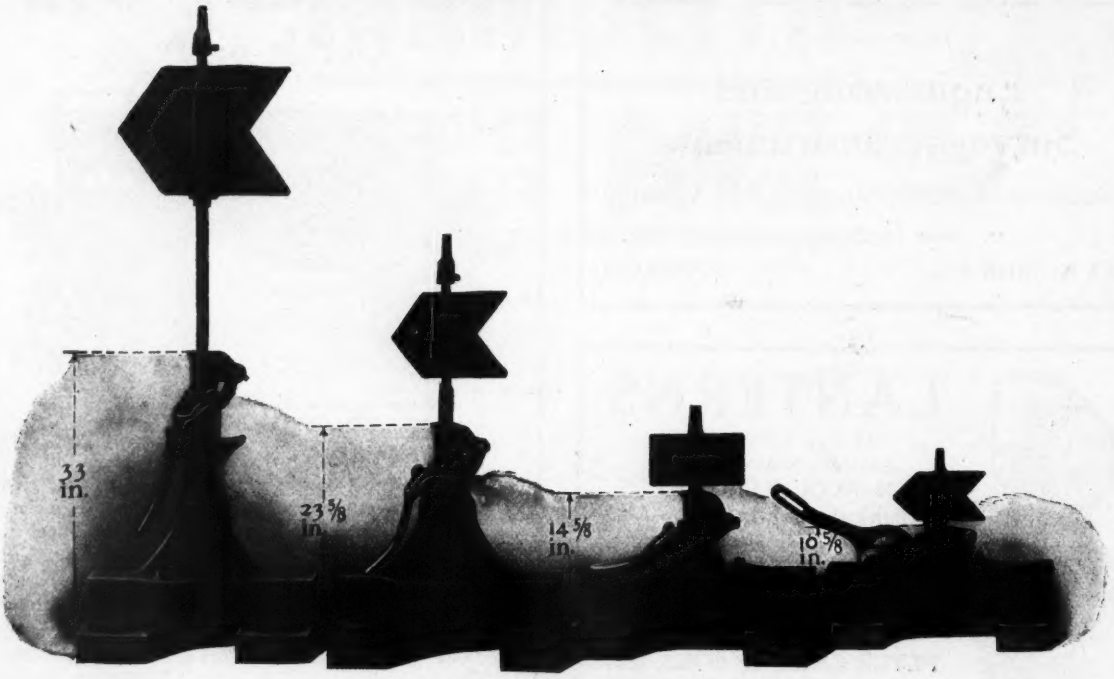
Name .....

Occupation ..... R. R. .....

Address .....

Sales Service Company—Advertising—Chicago 5

RAMAPO



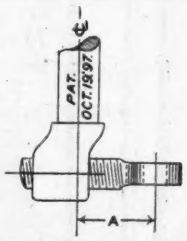
STYLE NO. 17 STYLE NO. 18 STYLE NO. 19 STYLE NO. 20

RAMAPO PATENT SAFETY SWITCH STANDS

1. POSITIVE THROW.—Ramapo Safety Switch Stands are rigid for hand operation. The operator raises the handle, thereby releasing the spindle from the automatic mechanism, then throws the switch, but cannot lower the handle or relock switch, unless the points are fully thrown.
2. AUTOMATIC SAFETY FEATURES.—A train or car can trail through a switch when set wrong locked with a Ramapo Safety Switch Stand, without breaking the switch points or injuring the switch stand. The first pair of wheels forces the switch points open compressing springs in the switch stand, and when points are half way thrown the springs snap the points the rest of the way. The stand is left locked in new position, just as if thrown by hand and is again ready for either hand or automatic operation.
3. ADJUSTABLE FEATURES.—All Ramapo Safety Switch Stands are furnished with adjustable throw and adjustable moving rods, unless otherwise ordered. Adjustable switch rods are not required as either switch point can be adjusted. The throw can always be adjusted to suit that of any switch, one-half turn of the eye bolt crank affecting the throw one-twelfth of an inch. See table of crank adjustments below. The distance of stand from switch can be readily adjusted with the adjustable moving rod without moving the stand on the ties.

CRANK ADJUSTMENTS FOR RAMAPO SAFETY SWITCH STANDS

THROW OF STAND	"A"		THROW OF STAND	"A"
3½″	2 11/32″		4¼″	3″
3⅝″	2 3/16″		4⅜″	3 3/32″
3¾″	2 23/32″		4½″	3 3/16″
3⅞″	2⅜″		4⅝″	3 9/32″
4″	2 7/32″		4¾″	3 11/32″
4⅛″	2 15/32″		4⅞″	3 7/16″
4¼″	3″		5″	3 17/32″



Write for descriptive catalogues on Switch Stands, Switches, Frogs, Guard Rail Clamps, Etc.

Manganese Track Work a Specialty

RAMAPO IRON WORKS

MAIN OFFICE: Hillburn, N. Y. WORKS: Hillburn, N. Y. and Niagara Falls, N. Y.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.

WITH WHICH IS INCORPORATED
ROADMASTER AND FOREMAN

BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

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Contributing Articles for Publication.

RECENTLY one of our subscribers called the attention of another employee on his railway to the prizes offered for articles on concrete construction, and he was favored by a letter which, we are glad to note, is an exception and a very rare one. In this letter he says, in part:

"Regarding your letter, and thanking you for notifying me, I beg to say that I know of no way that would be harder for me to earn $25.00 than by writing a prize article. Two years ago I promised a series of articles to an engineering journal. If offering a prize of $25.00 would secure a set of articles about our work that would be fit to print, I would certainly bulletin such offer in every camp and pay the prize money myself."

"Thanks again for giving me the opportunity, but as long as there are jobs open sweeping out stores, I don't think I will compete."

We are absolutely positive that a man who would write such a letter could never take the first prize, if more than one article was submitted. A man who would rather sweep out stores than write such a description, which is practically no more than writing up an engineering report, has missed his calling, we think, and would grace a job similar to the one mentioned in the last paragraph.

The consulting engineers who have made reputations, and consequently command large fees, are those who are capable of thoroughly sizing up a job and then writing a clear, concise report on it.

The men who write articles, who take an interest in conventions of associations which are organized to promote the efficiency and distribution of knowledge—these are the progressive men, the ones who are bound to go forward and not backward.

You will sometimes meet with a man who imagines that he has an all sufficient knowledge of his vocation. He neither gives nor accepts new ideas or methods suggested by others, no matter how good they may be.

New and better methods for doing work are being evolved daily. No man can afford to ignore the work of others in his own field. And no man should refuse to furnish information of value to others, if opportunity offers. It is an unwritten law of the engineering profession that all advances in the profession should be made known for the benefit of the public. That is the reason so few patents are taken out by engineers. The policy of an engineer should always be to advance the common knowledge of the profession, and if he has not this spirit, he is not a true member of the fraternity.

Roadmasters and Maintenance of Way Association.

THE ANNUAL convention of the Roadmasters and Maintenance of Way Association at Buffalo, Sept. 10, was a notable one in many ways. The attendance was the largest in the history of the association, and members registered from all sections of the country, including some from the Pacific coast. The number of new members enrolled was practically twice as large as in any previous year.

A fewer number of committee reports were submitted than in previous years. This number, however, proved ample to take up the entire time of the meetings, as reports were, in general, very complete and the subjects were gone into exhaustively. In this connection especial mention should be made of the report of the Committee on Foreign Labor because the subject is of paramount importance and it was handled authoritatively.

The members took part very actively in the discussion of the reports. In fact, it was quite generally necessary to limit the discussions in order to dispose of the subjects in a reasonable time.

The officers, especially A. M. Clough, president, and L. C. Ryan, secretary and treasurer, are to be commended on having one of the most enjoyable and instructive conventions ever held by this organization.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION CONVENTION.

The annual convention of the American Railway Bridge & Building Association will be held at Hotel Emerson, Baltimore, October 15, 16 and 17. Extensive preparations are being made for this convention, and judging from the interest shown this meeting will be one of the most interesting and profitable sessions held in recent years. The following is the program:

Monday, October 14.

Meeting of the executive committee at eight o'clock, followed by the president's reception and informal dancing.

Tuesday.

Morning Session.

Convention called to order by the president, 10 a. m.
Address of welcome and response.
Reading of the minutes of the last meeting.
Report of executive committee, secretary and treasurer and other committees.
Admission of new members.
President's address.
Appointment of committees.

Afternoon Session.

Reports of committees and discussions.

Evening.

A trolley trip to Bay Shore Park.

Wednesday.

Morning and Afternoon Sessions.

Reports of committees and discussions.
Unfinished business.
New business.

Thursday.

Morning Session.

Election of officers.
Selection of meeting place for 1913.

Thursday afternoon a boat trip to Annapolis has been arranged for. A light lunch will be served on the boat. Members and guests will be shown through the grounds and buildings of the United States Naval Academy, after which they will be received at the executive mansion by the governor of Maryland.

The Boys of the B. & B.

By Berton Braley.

Copyright 1912, *Wm. E. Magraw.*

When you ride across the torrent on a slender cantalever,
And you hear the waters roaring far below,
When a viaduct conveys you through the city's vast endeavor,
You can thank the "B. and B." that this is so;
They have been the toiling builders, they have been the men to wrestle
With a thousand woes and cares you cannot see,
And on every bridge and culvert, every viaduct and trestle
You are trusting to the "B. and B."

Every girder, every span,
Is according to their plan,
And when you travel on 'em, danger-free,
Over canyon, cut or street,
You rest easy in your seat—
And for that your thanks are due the "B. and B."

And the modest little structure of the country village station,
With its funny stove that's evermore aglare,
Or the terminal that's clanging with the traffic of a nation,
It's the busy "B. and B." that built it there!
Though it be a marble palace and a paragon of beauty,
Or a rough unpainted shanty that you see,
If it's used for railroad busy or is doing railroad duty
You can lay it to the "B. and B."

In a quiet rural spot
Or a desert, baking hot,
Where there isn't any water or a tree,
You are pretty sure to find
Something which will bring to mind
All the wonders that are done by "B. and B."

When contractors strike a river and they cannot get across it,
When they say the job's "Impossible to do!"
Then they call the "B. and B." in to construct a bridge and boss it,
And the "B. and B." proceed to put it through.
When the quicksand "can't be handled;" when the caissons "can't be driven;"
When the raging rivers go upon a spree,
When they're facing bitter failure and no hope at all is given,
Then they leave it to the "B. and B."

And the "B. and B." just grin,
As their labors they begin,
And they scarcely stop for dinner or for tea,
Till the trains begin to run
And the job that "can't be done"
Has been finished by the boys of "B. and B."

Outline History of Railway Bridge Building in the U. S.

By J. G. Van Zandt C. E.

Introduction.

It is always of interest and often of value to recall in a general way the efforts of the pioneers of any industry, who without modern equipment and data fought through the dubious forests of untried theory, overcoming great obstacles of design, and finally reached the light of an advanced economical construction leaving man one step nearer the desired goal of accomplishment.

It is probable that in no line of human endeavor is this more true than in the science of bridge building, for in the struggles of the pioneers the same problems of force and reaction presented themselves that appear in the designs of the present day, and possibly a study of the solutions of these master minds may present helpful suggestions for the solution of modern problems.

One very commendable feature of the most of the early designs was the evidence of the thorough study given each detail of the design. This example alone is worthy of its impression at this time when in the rush of work there comes the inclination to use standard details without investigation.

Early History.

The early history of bridge building is not complete, but there are records remaining of some admirable work which

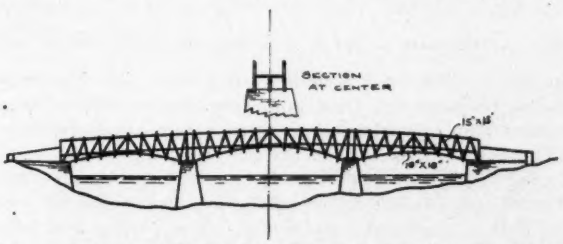


Fig. 1. Permanent Bridge Over Schuylkill River at Philadelphia, Built by Timothy Palmer in 1804.

was done, and many structures were constructed out of timber which are looked upon today as wonderful bridges. It must be remembered that the common necessities of today, such as nails, bolts and rivets, were not available for these pioneers and the tools likewise were crude and few in number. Many of the first bridges were therefore constructed by unskilled carpenters with axes and handsaws, from trees standing in the vicinity.

Previous to the advent of the railroad there was little serious thought of the importance of bridge building. Ferries were used to cross the larger streams and pile bridges or pontoons were built for others which could easily accommodate the light loads imposed upon them. Some splendid preparatory work for later railroad bridges was done around Boston, however, where the natural topographic conditions suggested bridge building. Most of these were pile bridges, such as the "Great Bridge" to Cambridge of 1660 and the York River bridge of 1761. Samuel Sewall who built the latter also constructed the "New St. Charles River Bridge" in 1786 which was 1503 ft. long on 75 pile bents.

The efforts of Thomas Paine in 1786 are notable as he made models of cast iron arch bridges and urged Congress to build one of 400 ft. span "to educate the public," his motives being purely philanthropic. Riddle and Hale were also among those who promoted bridge building and paved the way for the railroad bridge by their monumental structures at Manchester, N. Y., and over the Connecticut River in 1785. Col. Enoch Hale is credited with having been the originator of the scientific building of wooden bridges in the United States.*

*See History of Bridge Engineering.—H. G. Tyrrell.

Probably the longest of these early pile bridges was the Cayuga Lake bridge which was just one mile in length and had 211 pile bents. Timothy Palmer, one of the foremost of the early builders, constructed his first bridge in 1792 over the Merrimack River, using spans of 160 ft. and using the radical departure of the arch truss. It was replaced in 1810 by James Finley's chain suspension bridge, the first of its kind, which is still in use having been strengthened by two additional wire cables for the railway track. The combination pile and arch bridge was used by Palmer in his bridge at Piscatauqua which had 2,362 ft. of pile and 244 ft. of arch construction and was built in 1794.

The first attempt to build a simple truss bridge was made by Palmer in 1804 in his "permanent bridge" over the Skuylkill River at Philadelphia. (Fig. 1.) This bridge consisted of three wooden arches, two of 150 ft. and one of 195 ft. span. It was altered in 1850 "for also carrying a railroad track." This design was followed in his bridge at Easton, Pa., built in 1805 which continued in service nearly 90 years.

Theodore Burr was another illustrious pioneer who built some remarkable truss bridges, involving a radical departure from the arched truss form. His bridge at Waterford (Fig. 2) had four spans, the longest being 180 ft., and it remained in use until burned in 1909 when it was replaced by a steel structure. "This was probably the most scientific design for an all-wooden truss bridge ever invented and for half a century it stood unrivalled for cheapness and efficiency."*

*See Johnson, Bryan, Turneaure "Theory and Practice of Modern Framed Structures."

The "Columbia Covered Bridge" at Philadelphia was built by Burr in 1834 for the Columbia Railroad (Phila. & Reading) and it continued in use for 50 years, when it was replaced by one of iron. Another bridge called the "Columbia" was constructed by Burr in 1812 over the Susquehanna River and after being washed out it was rebuilt in 1832. It was burned in 1863 during the Civil War to stop the troops from crossing and in 1869 the Pennsylvania Railroad bought the old piers and rebuilt the bridge with 26 wooden spans and 3 iron spans using Howe trusses. In this form it continued in use until 1896 when it was rebuilt in steel. The Burr bridge over the Potomac at Washington was first built in 1809 but was destroyed by a flood and rebuilt in 1835 after four years. It was damaged by subsequent floods but in 1843 it was reopened as

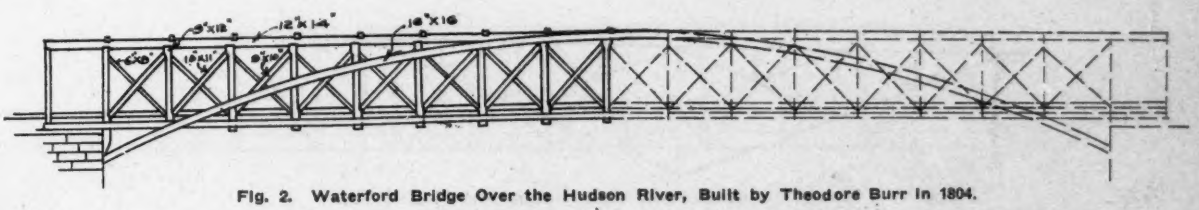


Fig. 2. Waterford Bridge Over the Hudson River, Built by Theodore Burr in 1804.

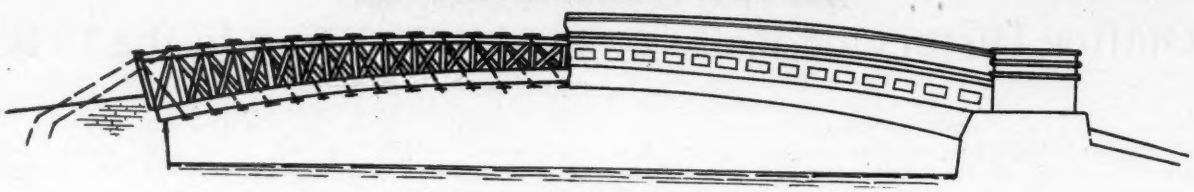


Fig. 3. Colossus Bridge at Fairmont, Pa., Over Schuylkill River, Built by Louis Wernag in 1812.

the "Old Long Bridge" and in 1867 was used by the Baltimore & Potomac Railroad which purchased it in 1870 keeping a highway at one side. Water sometimes rose two feet above the bottom chord but it continued in service until 1905 when it was replaced by a steel bridge. The only Burr bridge still standing is the three span bridge at Bethlehem, Pa., the north span of which dates from 1816. After 96 years of service it is one of the best preserved of the old wooden bridges and makes a striking contrast with the modern metal trusses near by.

Among the early American bridge builders Louis Wernwag distinguished himself in the design and construction of the "Colossus Bridge" at Fairmont, Pa., in 1817 with a single arch span of 340 ft. 3¾ ins. (Fig. 3). This replaced the third of James Finley's suspension bridges at the same site which was said to have been "aided by an intermediate pier." This arch bridge became an interesting chapter in the history of the contest betwen the truss builders and the suspension bridge builders of the early days. It was replaced in 1838 after a fire, by another suspension bridge, built by Chas. Ellet which remained in use until 1874 when the present double-deck truss bridge was constructed.

Wooden Railroad Bridges.

The railroad soon became the mightiest factor to influence the construction of bridges in the United States. Louis Wernwag of the "Colossus" built his first railroad bridge in 1830 over the Manoguay River on the Baltimore and Ohio Railroad. All of his bridges were of a similar arch type and there were many of them. His last was the great Harper's Ferry Bridge used by the B. & O. R. R. for many years. There were a number of bridges built by this road in 1838 which were designed by the chief engineer, Benj. H. Latrobe, patterned after the Schauffhausen bridge in Germany but made more rigid with counter braces. Two of these over the Patapsco River had spans of 110 and 150 ft. and cost $140,000.

The first step toward the modern truss was made in 1820 by Ithiel Town in his patent lattice truss (Fig. 4) of which so many railroad bridges were constructed all over the United States. The top and bottom chords held the diagonal planks together and were spiked with wooden pins. It was the origin of all lattice construction which has been used so much in modern bridge building. One of these was used on the B. & O. R. R. near Philadelphia

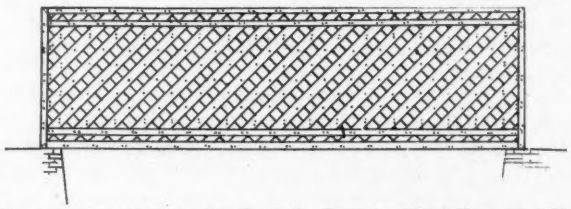


Fig. 4. Lattice Used on the B. & O., Built by Ithiel Town in 1835.

but most of the bridges built by this road after 1840 were of the Bollman and Fink type (Fig. 5) and thereafter it appears that each railroad fostered a new type of bridge.

The patent truss of Col. Stephen H. Long of the U. S. Engineers in 1836 was a very substantial wooden truss (Fig. 6) and like the Town truss was often combined with the arch in long spans. In 1844 a railroad bridge was built by Geo. W. Whistler of the "Long" type with seven spans of 180 ft. each, and four small spans, having a total length of 1,260 ft. It was blown bodily off the piers in 1846 but a new one of the same type was built in 45 days which

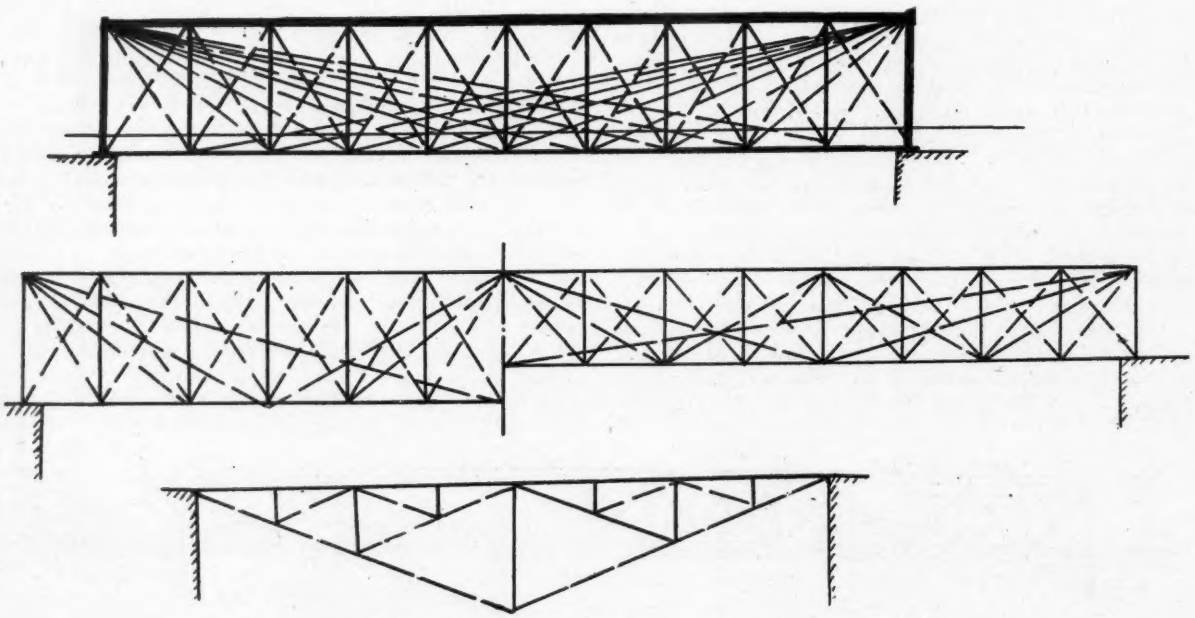


Fig. 5. Bollman and Fink Trusses and Combinations.

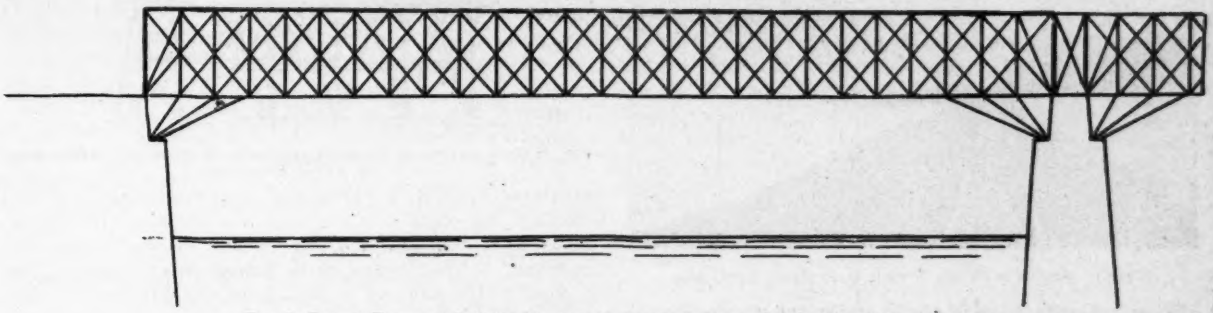


Fig. 6. Patent Truss of Colonel Stephen H. Long, Built by Geo. W. Whistler in 1884.

remained in use until 1864 when it was replaced by a metal bridge, designed by Jas. Laurie. This "Laurie Bridge" was made of iron imported from England at a cost of $277 per ton but was replaced by the present double-track deck plate-girder on the old piers of the Whistler-Long bridge.

It was in 1840 that great impetus was given in the progress of Railroad Bridge Engineering by the invention of the Howe truss (Fig. 7). Wm. Howe patented his combination wood and iron truss in which the chords and braces were of timber and verticals of iron with screw ends upset, though the chords were of uniform section throughout. This form grew rapidly in favor on account of its economical construction and even after 1844 when Caleb Pratt patented the standard truss (Fig. 8) which now bears his name, the Howe truss maintained the favor it had gained.

A remarkable wooden arch bridge over the Cascade Glenn on the New York and Erie Railroad was built in 1848 by Col. J. W. Adams. The three hingeless arch trusses were 12 ft. deep at the center and were supported in

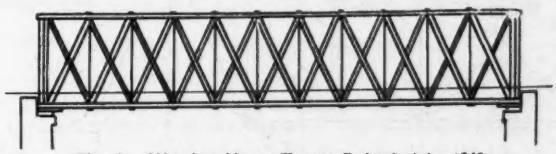


Fig. 7. Wooden Howe Truss, Patented in 1840.

spans of 275 ft. by masonry piers which reached clear up the 45 ft. rise to the deck which was 25 ft. wide with a single track.

Wooden bridges were always in favor where timber was plentiful and rapid construction desired and even in modern construction, as is well known, the pile trestle is used very extensively. Among the notable timber trestles of the early days was the old Portage Viaduct carrying the Erie Railroad over the Genesee River at a height of 234 ft. above the water. It consisted of two lines of wooden Howe trusses on timber towers, each tower having three bents braced together. This trestle cost $140,000 and was the boldest ever constructed. It was burned in 1875 and replaced by a metal viaduct.

An interesting wooden bridge of the Burr type was built in 1851 over the Connecticut River near Woodsville, Vt. It was the fifth timber bridge to be built on the same site and carried a highway on the lower chord. It was strengthened in 1886 to carry the single track of the Boston & Maine Railroad above the shingled roof and thus it remained in use until 1903 when it was replaced by a steel bridge.

The Northern Pacific Railroad trestle at Merent Gulch, built in 1883, was constructed of wooden Howe trusses on pile and timber towers. It was renewed a few years later in steel. The St. Paul, Minneapolis & Manitoba Railroad built a 750-ft. wooden trestle 211 ft. high in 1890, with a central span of 120 ft. supported by triple bents.

On the recent construction of the Chicago, Milwaukee & Puget Sound Railroad numerous large timber trestles were built, the highest being that at Heason Creek, which was 190 ft. high. The use of aerial cables facilitated the erection of these and other trestles and is an interesting development as compared with the practice of the Union Pacific Railroad of the early days on which crude suspension bridges were used to carry the temporary track over the ravines until the high embankments were completed.

Among the present long pile trestles the one at Lake Pontchartrain is the longest. This crosses 6 miles of lake and 16 miles of swamp and with its total of 22 miles is the longest bridge of any kind in the world. A later one built by the Southern Pacific Railroad across the Great Salt Lake is nearly 20 miles long and has a gravel deck, having recently been raised and largely filled in on account of the rise in the level of the lake. It may be remembered that owing to the request of Brigham Young and his following the location of the first transcontinental line was altered to pass nearer Salt Lake City, and instead of taking the natural southern route around the lake now used by the Western Pacific Railroad, a detour was made around the north end to the original location so as to connect with the line being built out from San Francisco. It was at "Promontory," Utah, that the last rail was laid which united the tracks of the Central Pacific built from the West and the Union Pacific from the East. At that time the level of the lake was said to be fifty feet above its present level and no thought of crossing was entertained, but later surveys by the railroad disclosed the desirability of crossing. Owing to disastrous storms several survey parties making soundings were lost and the project abandoned for many years. The lake changes its level every season, and as it has no outlet it may some day rise to the old shore-lines on the hills surrounding it. After a wet winter recently the lake rose some twelve feet and approached the track of the railroad trestle so closely that on windy days the rails were kept wet from the waves. The

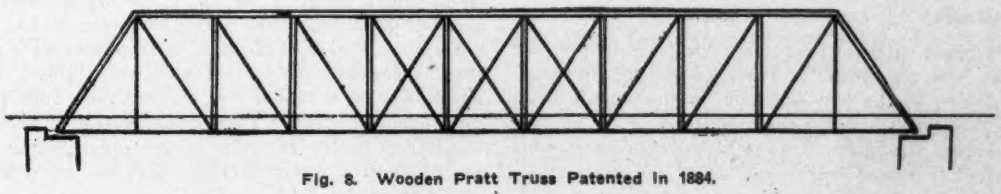


Fig. 8. Wooden Pratt Truss Patented in 1884.

Plate I. Southern Pacific Trestle Over Great Salt Lake.

officials naturally became apprehensive and the result was that the appropriations were made for the raising of the entire 21 miles of this unusual bridge. (Plate I.)

Iron and Steel Bridges.

The use of iron bolts in bridges marked the beginning of the development of iron structures and soon all-iron bridges began to appear. The first all-iron structure was built in 1823 for the Stockton & Darlington Railroad in England. In the United States the first all-iron trestles were built by Albert Fink, of the B. & O. R. R., in 1853, being all cast iron except the wrought iron bracing rods. One of these early trestles, the Tray Run Trestle, was 445 ft. long and 58 ft. high and was built on continuous masonry walls. (Fig. 9.) It remained in use until 1887 when it was replaced by a steel viaduct.

Cast iron was employed in timber bridges for connections, but in 1833 the first cast iron truss was patented by August Canfield. One was actually constructed across the Erie Canal in 1840 by Trumbull, being the first of its kind. An all-iron

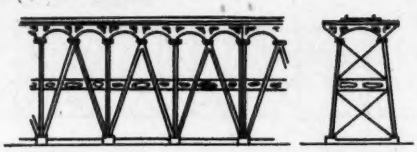


Fig. 9. Fink Cast Iron Trestle Used on B. & O. R. R. in 1853, and for 34 Years Thereafter.

road near Troy, N. Y. (Fig. 10.) This bridge was of 146-ft. span and the posts were cast iron, but the lower chord was of wrought iron links and was the first to employ pin connections. In the building of the Lehigh River bridge for the Lehigh Valley Railroad in 1863, John W. Murphy first used wrought iron for all compression members and with this modification the type continued in use until 1885 as the Murphy-Whipple truss. In the Pennsylvania R. R. bridge built in 1861, Mr. J. H. Linville first used wide forged eyebars and wrought iron posts in the web system, thus establishing with Murphy and Whipple the distinctive practice of the eye-bar pin connected truss still used on all long span metal bridges.

An interesting Whipple bridge built by Murphy over the Saucar Creek for the Northern Pennsylvania Raliroad had a clear span of 152 ft., but was never used. In 1859 a Whipple bridge was built by the Lehigh Valley Railroad near Philipsburg, N. J., with a span of 165 ft. It was one of the first trusses pin-connected throughout, and was moved in 1869 to Towanda, Pa., as a part of the wooden bridge there, and again in 1879 it was moved to Shepards Creek on the Southern Central Railroad.

The first bridge over the Ohio River was built in 1863 by J. H. Linville, having the unusual span of 320 ft. This was

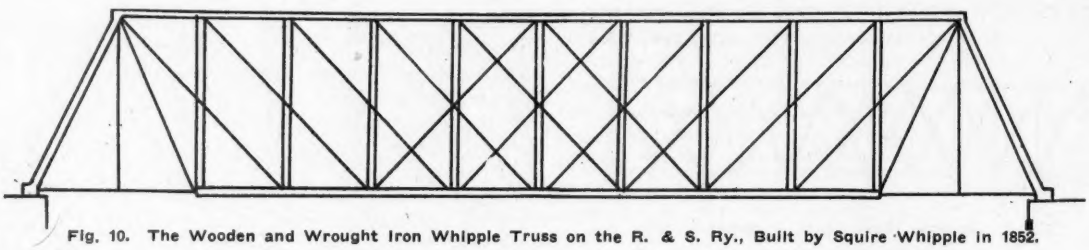


Fig. 10. The Wooden and Wrought Iron Whipple Truss on the R. & S. Ry., Built by Squire Whipple in 1852.

Howe truss was patented in 1846 by Fred Harbach, using cast iron posts and wrought iron rods. He built a 30-ft. span for the Boston & Albany Railroad in 1847, near Pittsfield, Mass.

Several iron Howe bridges were built by Nathaniel Rider in 1847 for the New York & Harlem Railroad. The failure of one of the Rider bridges and a similar one over the River Dee in England made the officials of the B. & O. R. R. order all iron bridges removed as untrustworthy and wooden trusses substituted!

The first great impulse toward the general adoption of iron for railroad bridges was given by Benj. H. Latrobe, chief engineer of this same B. & O. R. R., in 1852. In this year the Bollman truss at Harper's Ferry of 124-ft. span was built and also the Fink bridge over the Monongahela River with three spans of 205 ft. each. The Pennsylvania Railroad also built a number of Pratt trusses of iron during the years from 1851 to 1861 and became the promoter of that type of truss.

Squire Whipple patented his remarkable truss in 1840 and seven years later published "A Work on Bridge Building," which is said to be the first scientific treatise on the exact computation of stresses and is the foundation of the modern theory of framed structures. One of his "double intersection Pratt trusses" (patented four years before the Pratt truss) was constructed in 1852 on the Rensselaer & Saratoga Rail-

exceeded in 1868 by the Fink bridge over the same river at Louisville which had one span of 360 ft. and one of 390 ft. Linville again took the honor of building the longest span in 1872 when he built over the same stream at Cincinnati with a span of 420 ft. and clinched it again in 1876 with his Cincinnati Southern Railroad bridge with a 519-ft. span.

The Atchison bridge over the Missouri, built in 1873, had three fixed Whipple spans and one draw span of 365 ft. It was used by seven different railroads and had an eighteen foot highway at one side.

The building of the Cincinnati Southern Railway marked an important step in the improvement of bridges in the United States. It was during the construction of this road in 1876 that the first railroad cantilever bridge appeared, being located at the Kentucky River by Chas. S. Smith. The site was one used by a suspension bridge which was started 22 years before by John Roebling, designer of the Brooklyn Bridge, but was never completed. The single track passed between the old stone towers which still remain at either end of the bridge and were used as anchorage during the process of erection. The trusses were replaced in 1910 by heavier ones for a double track bridge, the deck of which was 30 ft. above the old one, and built without interfering with traffic. This bridge is said to be the highest and largest cantilever bridge in the United States, being supported on steel towers 315 ft. above the river, with a span of 551 ft. (Plate II.)

The Cincinnati Southern R. R. was one of the largest users of iron trestles at the time of its construction and a number of important ones were built, the Horse Shoe Run trestle being 900 ft. long and 89 ft. high with diagonal braces between the bents.

Until 1880 the Linville bridge on the Cincinnati Southern R. R. remained the longest truss span in the United States, but in that year the Kentucky Central R. R. built the unequaled span of 550 ft. over the Ohio at Cincinnati. This was for many years the longest simple truss span in the world.

There was an iron arch bridge built in 1870, however, having a 520-ft. span, which marked the most important advance in the development of railroad bridge building in the United States. This was the St. Louis bridge over the Mississippi River built by Capt. Jas. B. Eads, and was the first and largest railroad arch ever built in America. There were three spans, the center being 520 ft. and the others 502 ft., and the upper deck was 54 ft. wide and used for a highway, while the lower deck has two lines of railroad near the two outer of the four trusses. The total cost of this remarkable arch, including the tunnel approach, was $10,000,000 and it remains the most expensive of its kind

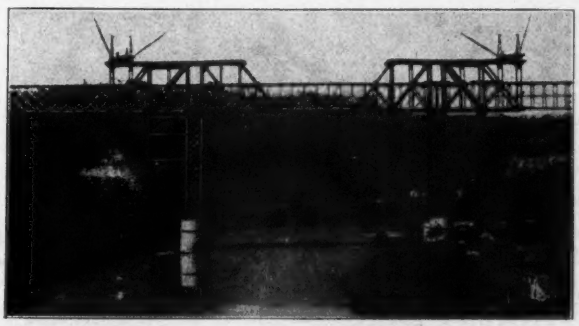


Plate II. Kentucky High Bridge.

ever built. It is notable for its great span, its difficult erection, its high cost and its unique design—for it has not been nor probably ever will be followed, as a type for other bridges. Its construction gave immense impulse in the investigation of the advantages of the arch type of bridge and many large railroad arches have been constructed as a consequence. The trusses were erected by the cantilever method with balanced reactions on opposite sides of each pier. The cantilever ends were supported by multiple wire rope guys carried over wooden falsework towers which were raised and lowered by hydraulic presses. In order to close the truss during hot weather, troughs were built around the tubular chords and packed with ice to counteract the expansion of the steel. Upon completion, after five years of work, it was severely tested with a line of fourteen locomotives on one track. The creeping of the rails on this bridge has often been mentioned as one of the interesting features, as the deflection on the long spans increases this action, which cannot be prevented by the use of anti-creepers without putting indeterminate stresses in the bridge. The rails are therefore allowed to run freely and have moved as much as forty-two feet in a single month. Devices consisting of switch points have been provided at eight points on the bridge to handle this rail, requiring the services day and night of as many men.

The experiments made by Geo. Stephenson in 1847 on the strength of cast iron and wrought iron marked an epoch in the development of bridge building and led to the construction of plate girder bridges which have since become so popular. In this year Jas. Millholland built the first tubular plate girder bridge in the United States on the B. & O. R. R. with a span of fifty feet, the sides and bottom being wholly of wrought iron, but the top flange was "reinforced with a 12 in. x 12 in. timber." The plates used were 38 in. x 72 in. deep and the whole bridge cost $2,200, weighing but 14 tons. One of the earliest girders in America was built by the Pennsylvania Railroad at South Fork, Pa., which continued in service for forty years. In 1860 the Boston & Albany Railroad constructed a remarkable plate girder bridge which was designed by E. S. Philbrick.

The largest tubular plate girder ever built was the old Victoria bridge over the St. Lawrence River at Montreal, designed by Robt. Stephenson in 1854. The floor and roof were of stiffened plates with ventilation holes for the locomotive smoke in the roof. These holes were found insufficient and a strip of iron was removed from the roof and replaced with angles. A permanent traveler was provided on the roof for inspection and painting, the area covered by each coat of paint being thirty-two acres! This bridge remained in service nearly half a century and was replaced in 1898 by simple spans of 254 ft. each, there being 24 in all, carrying a double track for the use of both steam and electric cars on the same tracks. This last bridge, weighing twice as much as the former, cost only $1,500,000, whereas the old tubular girder is said to have cost over $5,000,000, showing the economic development in the interim. The longest plate girder bridge in America is the double track

Fig. 11. The Post Truss Patented by S. S. Post in 1865.

bridge over the Susquehanna River at Towanda, on the Lehigh Valley Railroad, which has thirteen spans of 129½ ft. each and one of 120 ft. Longer single spans have since been built, but this still remains the largest in total length and size of girders.

FIG. 11.

The peculiar iron truss patented in 1865 by S. S. Post (Fig. 11) was used on the Erie Railroad at first, the earliest span being built at Washingtonville. In the following fifteen years a great many railroad bridges were built of this form, including those at Omaha, Leavenworth and Boonville. The theoretical economy of this truss with inclined web struts is now considered to be offset by practical disadvantages.

The modern type of railroad trestle reached its present stage of development in the building of the first iron Portage bridge in 1875 by the Erie Railroad. This replaced the timber bridge built by Geo. Morrison in 1852, which had uniform spans of 50 ft. each. The new bridge alternated with 50-ft. and 100-ft. spans some of the intermediate piers of the old bridge being discarded. There were six towers, the highest being 203 ft. and they were made heavy enough for two tracks, though only one was laid and the other never added. In 1903 the bridge was rebuilt and the deck replaced by heavier single track girders on the old towers. The new trusses were placed inside the old and work continued without interference with traffic.

The Erie Railroad also built the Moodna Creek trestle in 1907, which was 3,200 ft. long and 182 ft. high. The highest steel trestle in America is the Pecos Viaduct on the Southern Pacific Railroad, and it is unusual in having a pair of cantilevers with a clear span of 185 ft. in the center, which is 275 ft. above the river. The total length of 1,670 ft. has an average height of 129 ft. and was built by 67 men in 87 days at a cost of $238,000.

In the same way that the Baltimore & Ohio Railroad fostered the Fink type of iron bridge and the Pennsylvania the Whipple and the Pratt trusses, so the New York Central

Railroad become the promoter of the Town truss and latticed riveted bridges. The first iron bridge built by this railroad was over the Mohawk River in 1858. It was a riveted lattice bridge designed by Howard Carroll, while Geo. Gray was chief engineer of the road. There were numerous lattice bridges built in the following years, but many were of the Warren type (Fig. 12). The lattice girder has now given way largely to the plate girder which has deservedly become the popular short span bridge of America. In Europe, however, the lattice truss has remained very much longer and many railroad bridges have been built of this type, among which the Kehl over the Rhine is a notable example.

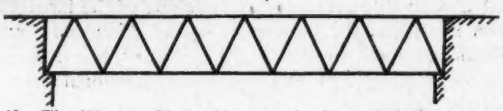


Fig. 12.—The Warren Girder Used on the New York Central in 1860.

Prior to 1860 the railroads designed and built their bridges in their own shops, but in the next ten years the most eminent bridge engineers organized contracting companies and took contracts for manufacturing and erecting patented designs. Competitive prices were asked for by the railroads on general specifications prepared by their chief engineers, the more prominent being used by many as standard. Of these the most important were those of Geo. Morrison, of the Erie R. R., in 1873, and of G. Bouscaren, of the Cincinnati Southern R. R., in 1875, and of C. S. Smith, of the C., M. & St. P. R. R., in 1877, and Chas. Hilton, of the Lake Shore R. R., in the same year, but principally the specifications by Theo. Cooper, of the Erie R. R., in 1879, which became the standard adopted by most of the railroads of the United States. Economy naturally favored the lowest bidder regardless of design, and therefore there have been and still are many bridges of inadequate strength in use on American railroads as a result of this system.

Plate III. Cairo Bridge.

The longest bridge in America in 1889 was the Cairo bridge over the Ohio River at its junction with the Mississippi, built by the Illinois Central Railroad in that year. It was among the last of the Whipple trusses to be built and was designed by Geo. Morrison. (Plate III.) The total cost was about $3,000,000, the Union Bridge Company being contractors for the entire structure. There were thirteen piers, ten of which were supported on pneumatic caissons, the other three being on pile cribs. In this remarkable bridge there were two Whipple trusses of 518-ft. span, seven of 405-ft. span and 53 simple deck trusses with spans from 256 ft. to 106 ft. each. The total length was 10,560 ft., exclusive of the two miles of pile trestle approaches. At the time of construction this bridge was the longest and largest ever built and was completed in the remarkably short time of two years. While this bridge has but a single track it has accommodated the heavy traffic of the main line of the Illinois Central R. R. ever since its construction, but has been repaired and reinforced from time to time to take the heavier rolling stock which came into use. There have been a number of derailments in the history of its life and some have been narrow escapes for the big trusses. There are two 5-degree curves on the short spans (Plate IV), and as the total angle is over 90 degrees, the side thrust of the long freight trains is very excessive and has necessitated alterations in these trusses. At high water this bridge spans a stream 20,600 ft. across at a maximum height of 104 ft. at low water and probably is the longest bridge of any kind carrying a railroad across a navigable stream.

Stone and Concrete Bridges.

It is of interest to note that the railroads in England followed the viaduct construction and for many years built large brick railroad viaducts, whereas in the United States the necessity for rapid construction made timber structures more popular. There were a number of large stone bridges built in America, however, and in 1835 Benj. Latrobe, of the Erie Railroad, built the large stone viaduct over the Patapsco Creek at Carrolton, which was followed in 1847 by the largest stone railroad bridge ever built located at Starruca Creek for

the same railroad. It had seventeen flat arch spans of 51 ft. at a height of 110 ft. and total length of 1,200 ft. and was built for single track only, but a second track has since been added without alterations. The material is sandstone and the piers are seven feet thick at the springs and twenty-five feet wide.

There were not many important stone bridges built again until about 1881, when the Philadelphia & Reading Railroad constructed the double track bridge at Wissahickon Creek, which has five spans of 70 ft. and a rise of 23 ft. A similar stone bridge was built by the Lake Shore & Michigan Southern Railroad with four semi-circular arches of 80-ft. span where three metal bridges had been successively constructed by the same company before.

Following the example of the Pennsylvania R. R., the New York Central and affiliated lines began replacing their old bridges in masonry, among which should be mentioned the solid concrete bridges at Danville and Terre Haute on the Big Four route, with their multiple arches above the main arch ring, supporting the floor system.

On account of the lack of definite knowledge of the behavior of reinforced concrete bridges under live loads the development of this type on the railroads was slow at first, but after the experiments by the Austrian Government with

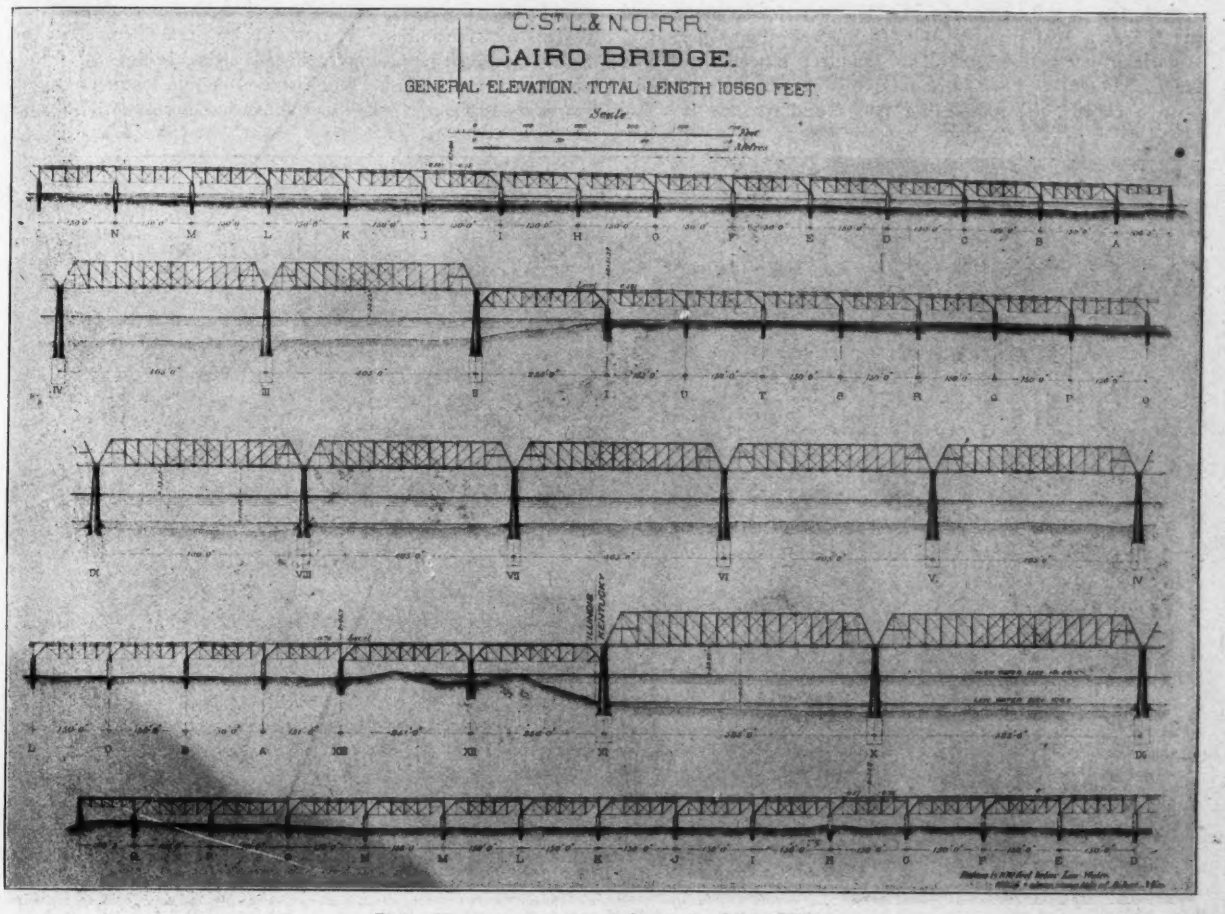


Plate IV. Arrangement of Spans in Cairo Bridge.

each, but it was replaced in 1909 by a single concrete arch.

One of the most notable stone bridges in the United States is the Mississippi bridge at Minneapolis carrying a double track on four spans of 100 ft. each, fifteen of 80 ft. and three smaller arches. The material in the piers is gray granite and limestone above and as a portion is built on a 6-degree curve just below the St. Anthony falls, it is very picturesque.

When the Pennsylvania Railroad began replacing its wooden and iron bridges with permanent ones of stone and concrete in 1888, under the direction of its chief engineer, Wm. Brown, the greatest impetus was given to the building of railway bridges of masonry that it ever received. Several of these withstood the Johnstown flood of 1889 and the severe test was so satisfactory that for twenty years it became the policy of that road to renew all bridges in masonry. Some bridges of large dimension were constructed as a consequence, among which the Rockville bridge of 48 spans of 75 ft. each was a notable example. This was constructed in 1901 of solid concrete without reinforcement on the site full sized arches in 1895, the use of reinforced concrete rapidly increased.

The original plans for the extension of the Seaboard Air Line to Key West, Florida, included several long railroad reinforced concrete bridges across the Gulf of Mexico from Long Key. On account of many storms and the loss of equipment, steel girders were used on the longest, although several long concrete bridges were built. It is said that the stone for these bridges was quarried in the Palisades on the Hudson River and shipped to the site of the construction work in large barges especially constructed for the purpose.

Reinforced concrete is now being used for all forms of railroad bridges and many roads are using slabs, piles and stringers of concrete, which are made at convenient points and shipped to the bridge sites much as timber was shipped in former days.

Modern Bridges.

A remarkable example of modern bridge engineering is the Niagara railroad arch built by the Pennsylvania Steel Com-

pany near the Niagara Falls. It replaced the famous old railroad suspension bridge built on the same site by John A. Roebling in 1855, which had a center span of 821 ft. and a height of 225 ft. above the river, being the first to use the wooden lattice stiffening trusses proposed by John C. Trautwine. The old bridge was famous as the first successful railroad suspension bridge built, the previous forms showing a wave in the deck "which rose up in front of the engines" and led Stephenson, who designed and built the old Victoria tubular bridge, to believe that suspension bridges were unsuitable for railroad purposes. His conclusion, however, is confirmed in the light of later experience and the change from the old to the modern bridge at Niagara was an interesting step in this development. The new bridge completed in 1896 at a cost of only $500,000 marked a new period in American bridge design. The spandrel braced two-hinge steel arch trusses have horizontal top chords and parabolic bottom chords, the span being 550 ft. and rise 114 ft. The depth at the crown is 20 ft. and the width 30 ft., while at the skewbacks the trusses are 57 ft. apart. Like the Eads bridge it carries both a double track railway and a highway, the latter, however, being on the lower deck. The whole bridge contains 3,600 tons of steel and when erected by the cantilever method there was an opening of eight inches between the ends of the top chords at the center. By operating the toggles at the anchors two men on each lower slacked them off under a stress of a million pounds each and lowered the ends of the semi-arches. One was lowered too far and had to be raised again by eighteen men on its toggle lever. It is said that a design submitted on the three-hinge principle required less metal, but the riveted arch was selected because of its esthetic qualities. Many railroad bridges of similar design have since been built both in America and elsewhere, the Zambesi arch of the Rhodesia railroad near the great falls of the same name being a notable example having a falls similarly near by.

Another interesting railroad bridge built across the Niagara River is the modern cantilever with suspended span constructed for the Michigan Central R. R. in 1883, by C. C. Schneider, with its total length of 850 ft. on two towers 245 ft. high. It had but two trusses originally, but in 1890 a third line was placed midway between the other two, supported on additional columns in the towers.

The McKinley bridge built at St. Louis by the Missouri Valley Bridge & Iron Company and recently completed, carries a double track railroad for 75-ton interurban electric cars besides two roadways. The tendency in American practice appears to be to use deeper and stiffer trusses with correspondingly lighter chords. The use of ballast decks is becoming more popular as the study of impact and vibration reveals its desirability. There is also a great increase in the use of plate girders, many railroads using bridges of standard length and design. The assumed engine loadings having increased to Cooper's E60 and above has necessitated the re-

Plate V. Concrete Bridge Across Galveston Bay.

building of many large bridges, and while pins are still used in long spans the bascule and lift bridges have nearly entirely supplanted the revolving spans.

One of the most interesting of the railroad bridges of modern design is the Red Rock centilever on the Santa Fe at Topock, Arizona, near Needle, California, over the Colorado River. It was designed by J. A. L. Waddell and constructed in 1889 with two arms of 165 ft. each, supporting a suspended span of 330 ft., making a clear distance between piers of 660 ft. The live loads of 3,000 pounds, for which it was designed, soon increased, necessitating the removal of the old floor beams and the addition of new heavier ones with two extra lines of stringers. The sub-verticals and hangers were also reinforced, but in 1910 when the double Mallet articulated engines appeared on the horizon these improvements were not sufficient. An additional pier was built on a pneumatic caisson in the center of the suspended span and by reinforcing all the members of this truss and in

An Arch of the Concrete Bridge over Galveston Bay.

the main cantilevers where necessary, the bridge was prepared for the heavy engines. Instead of the great cantilever bridge, which was one of the largest in the world, it then became a very unusual trussed bridge and gives an appearance as interesting as the grotesque "Needles" peaks near by.

The double track Mississippi Riber bridge at Thebes, Ill., was designed by Alfred Noble and Ralph Modjeski in 1905 for the Cotton Belt Railroad. This bridge has five spans arranged symetrically about the center and is 2,750 ft. long, having a clear distance between center piers of 671 ft. The weight of the entire bridge is 12,000 tons and the cost was $2,000,000.

Among the interesting railroad bridges of modern date is the Quebec cantilever bridge designed by the Phoenix Bridge Company in 1900. The center piers were 1,800 ft. apart and the total length was 3,300 ft., with but four supports! When nearly completed the south half failed and killed eighty men besides causing a loss of 20,000 tons of metal.

The most recent cantilever is the bridge at Beaver, Pa., built for the Pittsburg & Lake Erie Railroad and designed by A. R. Raymer, of that company. It has a clear distance between center piers of 769 ft. and including the Petit truss at the Beaver end, is 1,779 ft. in length.

Among the hinged types the heaviest of modern design is the three-hinge arch over the Menominee River near Iron Mountain, Mich. It was designed for Cooper's E50 engine loading with train load of 7,000 lbs. per ft. for iron ore traffic. The center pin being raised half way between the two chords is said to give lighter reversing stresses and a saving in metal. This bridge replaced an old Pratt deck of 255-ft. span built in 1885, but which was too light for the heavy rolling stock.

An unusual method of reinforcing was recently used on the St. Charles bridge over the Mississippi. This bridge was originally built in 1871 with Fink trusses, but in 1885 was rebuilt with Whipple trusses and a long trestle approach added. Additional metal was put in the trusses to change the loading from E25 to E50 and the columns and struts of the trestle were encased in concrete to give the needed reinforcement.

The use of concrete in modern bridge building has become very popular. An interesting example of this kind is the solid concrete bridge built by the San Pedro, Los Angeles & Salt Lake Railroad across the Santa River near Riverside, California, in 1903. (Plate V.) This bridge has eight semi-circular arches of 86-ft. span and a smaller approach arch. Its total length is 984 ft., with an average height of 55 ft. The two abutments and six of the piers are founded on bed-rock, but the seventh pier at a depth of 43 ft. below the water level was laid on a gravel strata ten feet thick which overlaid the rock and was converted into concrete "in situ" by forcing cement grout into it through pipes driven at intervals of five feet each way.

A reinforced concrete bridge was recently built across the bay at Galveston, Texas, and has 28 spans of 70 ft. each, with a rise of only 9 ft. There are three lines of railway and a 19-ft. highway on this bridge, which has also a rolling lift bascule span of 100 ft. at the center.

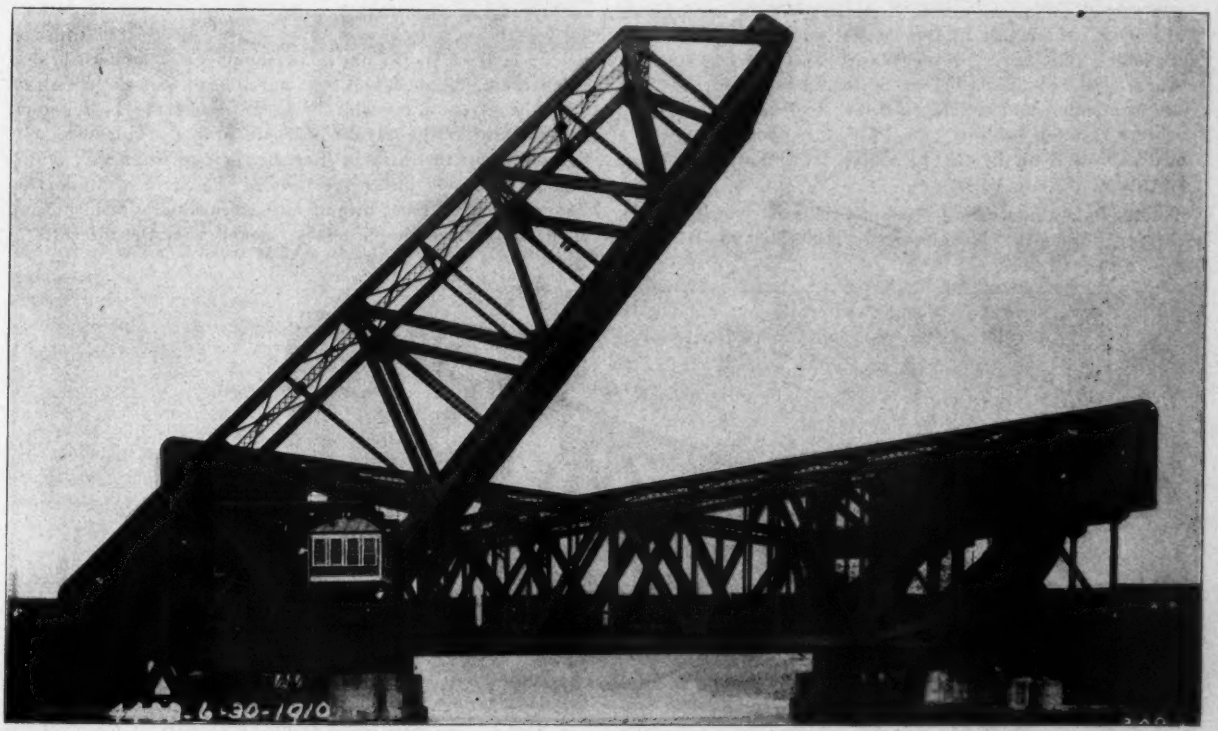


Plate VII.—Scherzer Rolling Lift Bridge at Chicago.

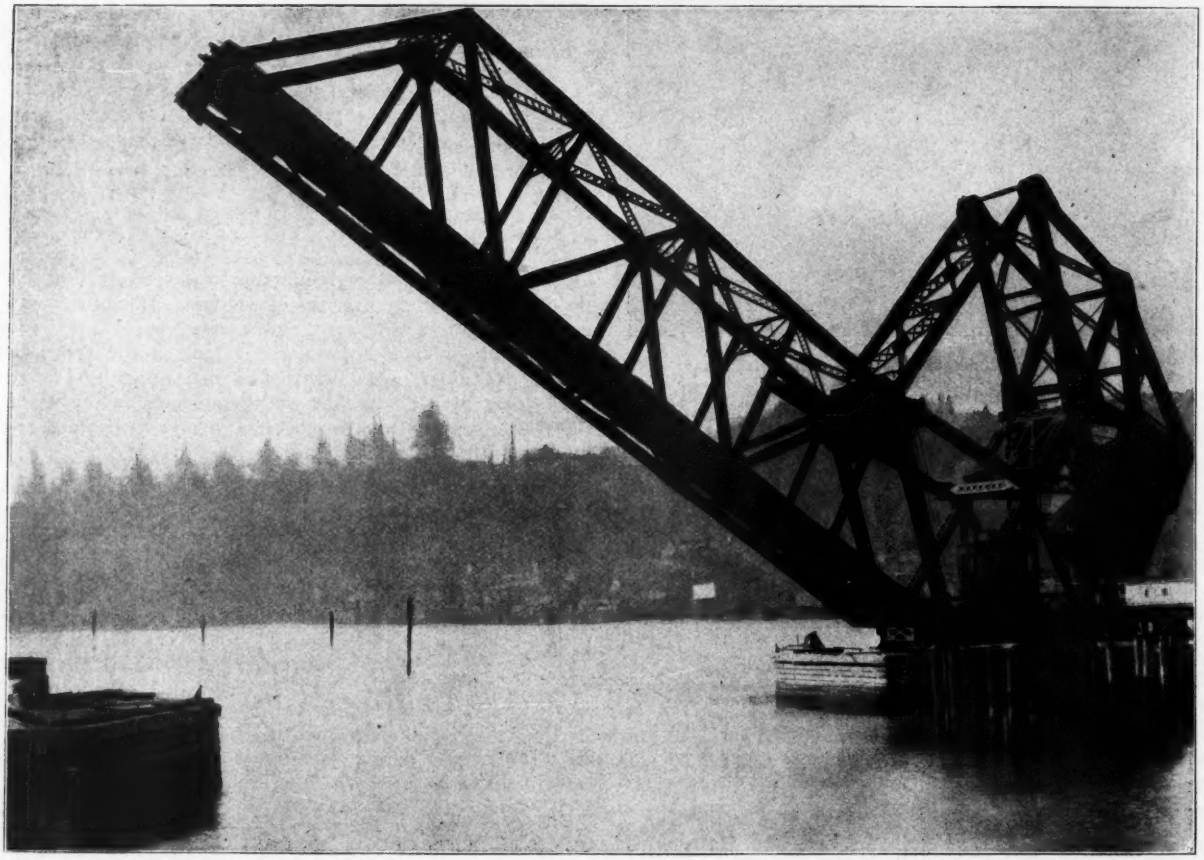


Plate VI. Scherzer Lift Bridge at Long Beach.

Among lift bridges the Scherzer rolling lift type has become very popular, the one at Long Beach, Cal., on the Salt Lake R. R., being one of the longest structures of its kind ever built. It is 234 ft. in length, of which 180 ft. spans the channel, the remainder being the segments upon which it rolls in opening and closing and the steel boxes containing concrete counter-weights. The bridge is opened in 40 seconds and was built by the Llewellyn Iron Works at a cost of $170,000. (Plate VI.)

Another very interesting modern bridge is the eight-track Scherzer rolling-lift bridge across the Chicago Drainage Canal. This bridge has four separate spans, each of which carries two tracks, and the bridge is one of the largest of its type ever constructed. It was erected by the Chicago Bridge & Iron Works and is a monument of modern bridge engineering. (Plate VII.)

In the class of movable bridges, one of the best known types today is the Strauss bascule bridge. This design is put forth by the Strauss Bascule Bridge Company, which was incorporated under the laws of the State of Illinois on February 26th, 1906, although Mr. Strauss, president and chief engineer of the company, looked after the interests of

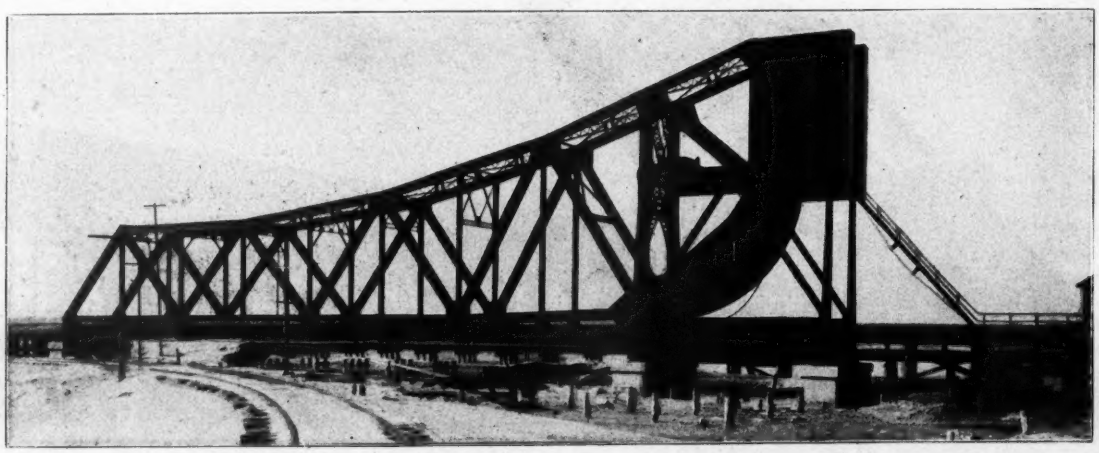


Plate VIII. Strauss Single Leaf Bascule Lift Bridge, over the Duwanisch River, Seattle Wash., N. P. R. R.

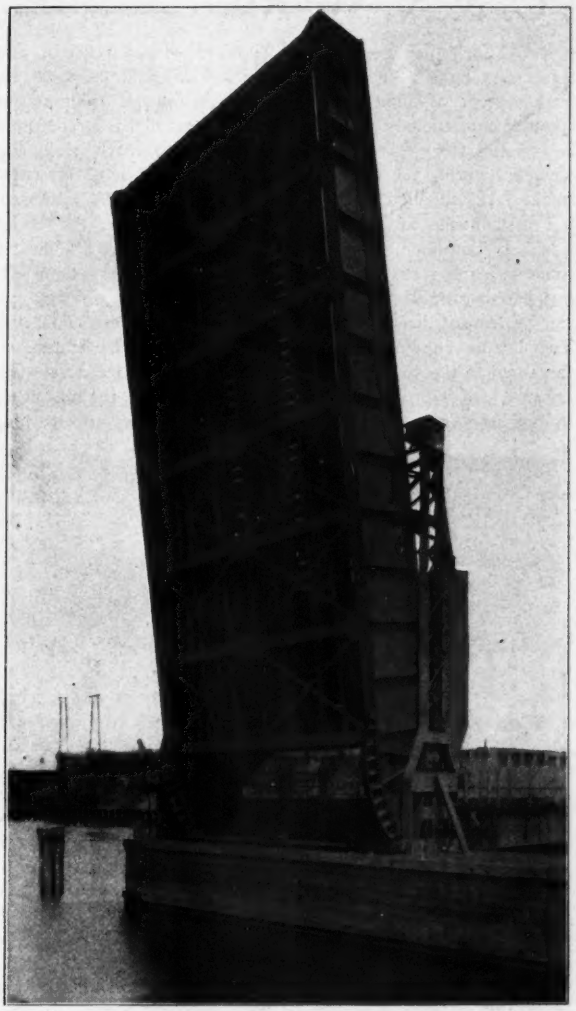


Plate IX. Strauss Bascule Lift Bridge Over Gangus River, Mass.

this bridge for a year or so before this in his practice as consulting engineer.

The number of Strauss Bascules has reached a total of eighty, some of the most notable structures being a single leaf design of 235 ft. and a double leaf design of 336 ft. The former is being constructed by the B. & O. at South Chicago and the latter by the Canadian Pacific at the Soo. Other notable structures of this type are the single leaf 186-ft. double deck bridge at Fort William and a 118-ft. single leaf structure for the Lake Shore & Michigan Southern at Fort Clinton, said to be the only four-track structure lifting as a unit.

One of the latest types of the Strauss bascule bridge is the so called heel trunnion type but the principle of all types is the same and embraces a parallel link mechanism for the counterweight arranged differently in the different types but accomplishing about the same result in all. The center of gravity does not move either vertically or horizontally during motion and the weight of the structure is carried on fixed trunnions and remains vertical and constant at all times. This produces a very simple and economical foundation.

We herewith illustrate a Strauss Heel Trunnion bascule and also one of the smaller plate girder bascules. The former is a 160-ft. single leaf single track span for the Northern Pacific at Seattle, and the latter is a 65-ft. single leaf double track span for the Boston & Maine, the operation and design of these bridges being as described above. The same company has also recently developed a type of direct lift bridge in which the span is lifted vertically any distance up to 150 ft. without the use of cables.

Some interesting forms of the vertical lift bridge, designs controlled by Waddell & Harrington, have been evolved. A double deck structure recently completed at Kansas City has two steam railway tracks on the lower deck and two street car tracks and team drive on the upper deck. When the span is lifted, it is raised just enough so that the lower deck connects up with the second deck. The tracks of the steam railway are then used for the street railway, so that there is little delay to vehicular and street railway traffic on the upper deck. This type of bridge would seem to have its widest application in double deck structures.

Conclusion.

Acknowledgment is made of the valuable works from which data has been taken liberally and especially of the History of Bridge Building, by Henry Gratton Tyrell; also of the assistance rendered by the many engineers and bridge builders mentioned in connection with the bridges described, and the illustrations furnished in several cases by the railroads using these structures. Many worthy designs were necessarily omitted in the above outline, but sufficient has been included to indicate the line of development of bridge building in the United States.

The Industrial Works of Bay City, Michigan, has recently issued a beautifully illustrated pamphlet describing the work of forty-two of its locomotive cranes which were purchased by the United States Steel Corporation and used in the construction of the large steel manufacturing plant at Gary, Indiana and at South Chicago, Illinois. It is stated that this is the largest individual order for locomotive cranes ever placed. The photographic reproductions show the use of the cranes from the breaking of the ground to the completion of the buildings and the handling of the products. The Industrial works manufactures, besides locomotive cranes, pile drivers, steam hammers, transfer tables, rail sawing machinery, drag line excavators, grab buckets and lifting magnets, cranes for railway wrecking purposes being one of the most important classes of lifting machines which this concern builds.

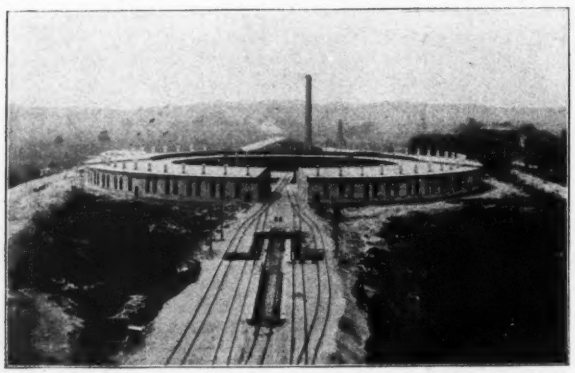
The Commercial Acetylene Railway Light & Signal Company is the new name of the Commercial Acetylene Company, New York. This company has for a number of years manufactured an acetylene lighting system for railway cars, signal lamps and marine signals. To these products it has just added a flash-light for railway signaling.

The Independent Pneumatic Tool Co., Chicago, has declared the regular quarterly dividend of 2½ per cent. It is reported that the business of the company for the fiscal year ending September 30 will show an increase of over 25 per cent over the previous year, with earnings sufficient to pay the 10 per cent yearly dividends and provide for a substantial reserve fund. Plans are now being prepared for a large addition to the factory at Aurora, Ill.

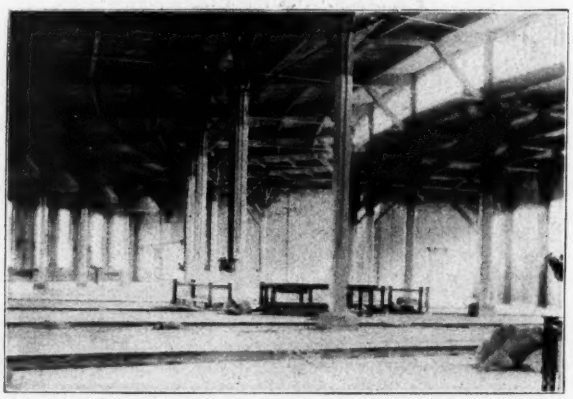
The McArthur Concrete Pile & Foundation Co., New York City, has been awarded the contract for placing the foundations for the Mississippi River Power Distributing Co.'s new substation at Page and Ogden avenues, St. Louis, Mo. This foundation will be composed of 600 pedestal piles. The company have also been awarded the contract for placing the foundations for the new mill of the Chalmers Knitting Co., Amsterdam, N. Y.

Proviso Terminal, C. & N. W. Ry.

A new terminal is being put in operation by the Chicago & North-Western Ry. at Proviso, 13 miles west of Chicago, which is the culmination of a number of improvements in this territory. The North-Western has three main lines running out of Chicago, the Milwaukee division running north, the Wisconsin division running northwest and the Galena division running west. About a year ago the Desplaines Valley Ry. was completed, connecting these divisions and forming an outer belt line for the transference of freight between the divisions, thus avoiding the passage of freight through the congested Chicago district. In connection with this plan, large freight yards were built at Proviso, just west of Melrose Park, where the Desplaines cut-off strikes the Galena or western division. A new engine terminal was therefore necessitated at this point in order to handle traffic quickly and expediously.



View of Proviso Terminal, C. & N. W. Ry.

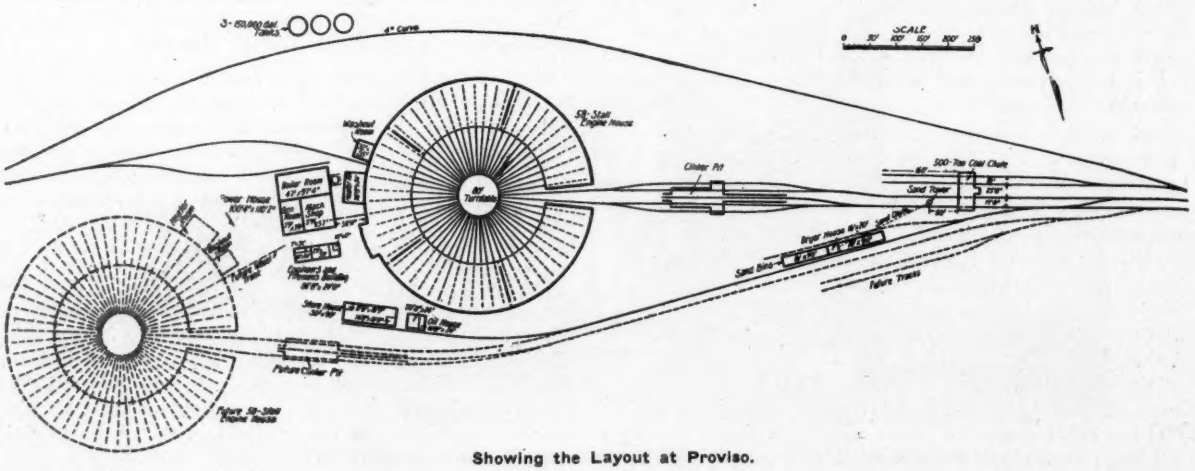


Interior of Proviso Roundhouse.

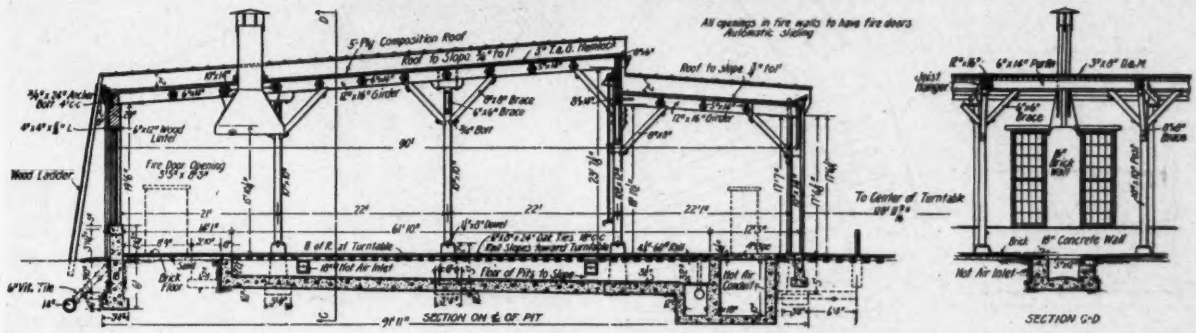
The terminal consists of a 58 stall roundhouse, engineers' rest room, coaling station, oil house, machine shop and power house, sand house and storehouse. The roundhouse is a standard No. 1 North-Western roundhouse, with brick walls, concrete foundation, wooden columns and girders and composition tar and gravel roof. There are four fire walls dividing the house into five sections, the doors in these walls being hung with the Allith Manufacturing Co.'s automatic door closing device. The paving is of hand burned vitrified brick laid on 6 inches of sand. Three 50-ton hydraulic jacks are provided for the drop pits and between every other pit is a short work bench and vise. Aside from a number of drop lights, all lighting in the roundhouse is done by lights placed on the wall at a height of about 8 feet. Each of these lights is supplied with a reflector and lense, one light being placed opposite each end of each pit. This system of lighting has been used on all roundhouses recently constructed by the North-Western and has been found very satisfactory. It makes the lights readily accessible and obviates lighting the upper part of the roundhouse. "Transite" smoke jacks supplied by the H. W. Johns-Manville Co. are used.

Two annexes are provided to the roundhouse, the boiler washout room being located opposite stall 33 and the heater room opposite stalls 29, 30 and 31. The washout system was installed by the National Boiler Washing Co. of Chicago. A fan system of heating was installed by the Green Fuel Co. Two hot air conduits 78 in. x 84 in. lead from the heater and fan room to the roundhouse proper. These are of concrete and are provided with steel sleeves and steel dampers for all outlets leading into engine pits. The clere story windows are operated in fours by Payson geared sash operators. Sanitary drinking fountains are provided at convenient places.

The method of placing and handling the concrete during construction is of interest. A construction track was laid across the middle of the engine house location running to one side of the turntable site. On this track two switches were put in, connecting to a track which was extended entirely around the outside of the outer wall stakes. This track arrangement is shown in the sketch. The excavated material from the turntable pit was loaded into cars on the center track, which was gradually lined over as the excavation was completed. The excavation from the engine pits and for foundations for the inside engine



Showing the Layout at Proviso.

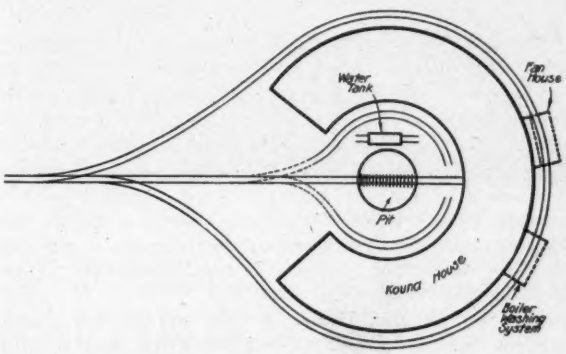

5-Ply Composition Roof
Roof to Slope ¾" to 1'
Roof to Slope ¼" to 1'
All openings in fire walls to have fire doors Automatic Sliding
Wood Ladder
Fire Door Opening
To Center of Turntable
Brick Floor
Floor of Pit to Slope
Hot Air Conduit
SECTION ON ℄ OF PIT
SECTION C-D
Hot Air Inlet
Brick 18" Concrete Wall

Construction of Proviso Roundhouse.

house wall was also loaded on cars on this track. On the opposite side of the turntable a short track was also layed for loading excavated material. Connection was made to this short spur by cutting the entering track back of the turntable pit, lining it over and connecting up. The end of the short track was carefully located so that a good connection was made without using switch rails. After the turntable pit was excavated, a crib was built across the center and a short section of track laid, which also could be connected to the entering track.

All of these tracks were used later to spot the mixer on, when putting in concrete. To furnish water to the mixer a large wooden water tank was spurred out on a short piece of track between the turntable pit and the inner engine house wall.

This track was cribbed up as high as it was thought safe in order to give a gravity flow of water as far as possible. It was found necessary to use a pump around the outside of the engine house. A small Emerson pump was used for this purpose.



Track Layout Used During Construction at Proviso.

Work on the fan house and boiler washout was left until the last, so the outside track could be kept in. When work was started on these buildings, it was necessary to tear up that part of the track on the locations of the buildings.

The walls of the engine house are built on chords. The concrete for these was poured in three sections. The footing was put in two sections, and the short wall above was placed later. Forms were built for one-fourth of the roundhouse, and these were moved around as the work progressed, saving not only a good deal of lumber, but a good deal of framing work. The lumber used was 2-inch matched and dressed on one side. Contractors frequently use 1-inch lumber, and make the concrete comparatively dry, but in this work wet concrete was used, necessitating heavier forms, because of the fact that the wetter concrete requires less tamping, and results in better concrete is placed by unskilled laborers.

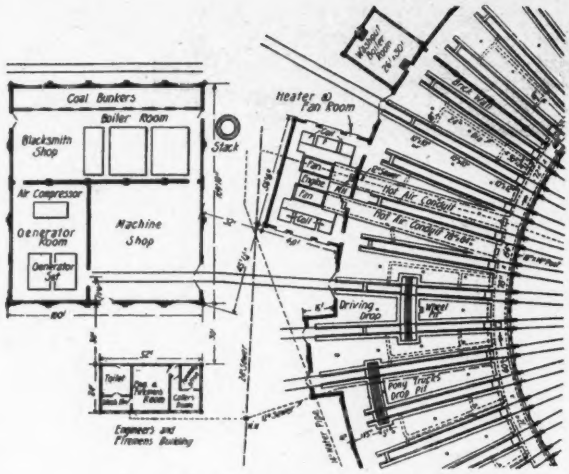
The center pier for the turntable rests on a square concrete pier, 10x10 feet. The foundation for this, and for all the buildings in fact, rest on a hard blue clay. No piles were used under the turntable foundation. The short ties for the turntable track were nailed to place in the forms, and the concrete was put in around them, which was much more satisfactory than if holes were left and the blocks grouted in place. Between the ties the concrete sloped down, following the general slope of the pit bottom towards the center. The summit at the center drains into the sewer system underlying the freight yards.

The turntable pit walls were built in a true circle. To obtain the required arc, 2-inch by 12-inch planks were used. The arc was layed on these planks by a template, and was sawed into correct shape at the shops. The two parts of a plank were placed opposite each other in the forms, at the correct distance. The form timbers were vertical and nailed to the curved sides of the planks. The forms were wired together, little bracing being required.

The turntable is of 80-foot span, having a hand lock and is equipped with a 12 H. P. electric tractor built by the Detroit Hoist & Machine Co.

Ash Pit Showing Forms Still on Concrete Rail Supports.

The power house and machine shop is located opposite track number 28, in a concrete and brick building 100x100 feet. This building contains the boiler room, 47x97 feet, the generator room, 59x39 feet, and the machine shop, 59x57 feet. In the boiler room are five 150-H. P. boilers supplying steam to two Russell engines direct connected to General Electric generators. These are respectively 150 and 200 K. W. Besides the switch board and generator, the generator room contains a Norwalk air compresser having a capacity of 1,000 cubic feet of air per minute. The partition between the generator room and machine shop is of hollow tiling, 6x8x12 inches, and the floors in both rooms are of creosoted wood blocks. The coal bunkers which are arranged along the exterior wall of the boiler room are equipped with Kinnear steel rolling doors. Ventilation is provided for by six 24-inch galvanized iron ventilators and Fenestra window sash is used throughout. Tungsten clusters are used for lighting. The power house stack has an inside diameter of 9 feet 4 inches, and an outside diameter



Plan of Machine Shop and Roundhouse.

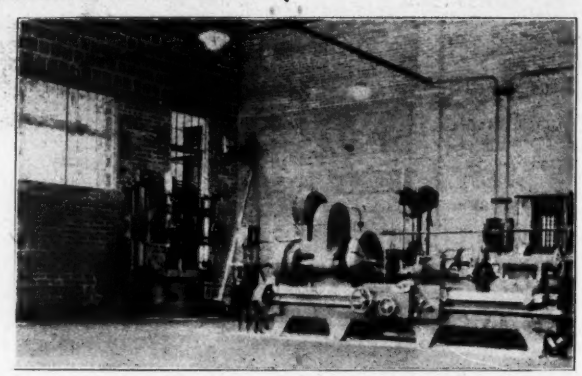
of 12 feet 8 inches. The following machine tools have been installed in the machine shop.

New Doty Shear.
Standard Bolt Cutter.
Two Niles-Bement-Pond Boring Mills.
Niles-Bement-Pond Lathe.
Niles-Bement-Pond Planer.
Niles-Bement-Pond Shaper.
Ransom Double Grinder.
Niles-Bement-Pond Drill Press.
W. F. & John Barnes Drill.
Niles-Bement-Pond Steam Hammer.

The engineers' rest room is a one-story brick building 24x84 feet, resting on a concrete foundation, and it is fitted with all modern conveniences, including metallic lockers, showers, concrete floors, etc. Two 18-inch Globe ventilators are provided and the heating is entirely by direct radiation.

The store house is 30x98 feet with an 8-foot basement. Near it is the oil house, smaller in size, but similar in construction. The floor and basement walls of each are waterproofed with asphalt mastic and burlap. The Bowser system of oil storage is used. The coaling station is a 250-ton wooden station of the Holman type. Sand storage is of the usual type. There are two cinder pits with a depressed track between them, the material being handled by hand. A view of one of the pits is shown.

Water is supplied by seven wells, storage being provided for by three elevated steel tanks of 150,000 gallons capacity each. These may be seen at the right in the general view of the terminal. A special line on high pressure supplies fire protection, hydrants being supplied through a 14-inch cast-iron pipe. Sewers are of 6-inch vitrified tile. The terminal was so laid out as to allow the future construction of another 58-stall roundhouse just west of the present one, when occasion requires. H. H. Decker, engineer maintenance of way, had supervision of the work, assistant engineer B. R. Culp being in direct charge.



Corner of Machine Shop, Proviso Terminal.

The Minneapolis, St. Paul & Sault Ste. Marie Ry. is reported to have purchased the Wisconsin & Michigan, a 135-mile line extending from Peshtigo to Iron Mountain, Mich. It is said that various extensions of the road are planned.

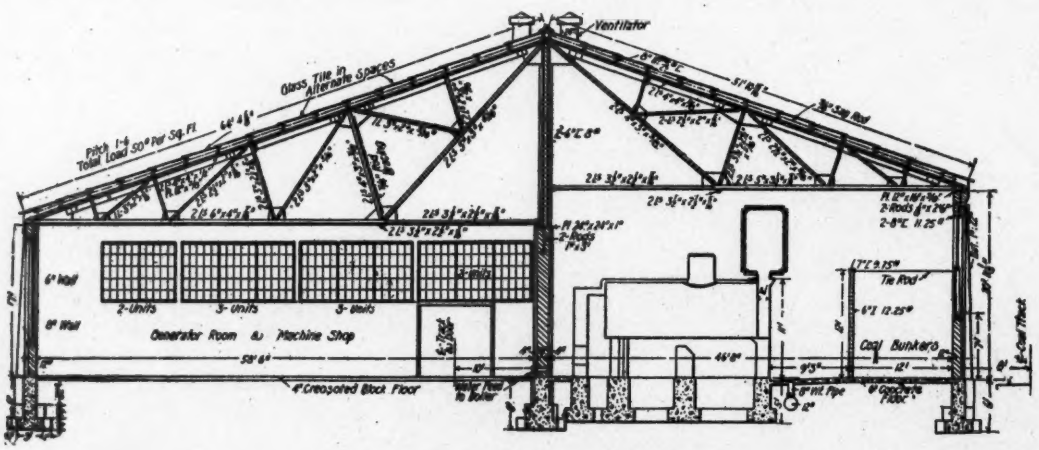
The New York Central & Hudson River has begun preliminary work on the construction of an auxiliary freight yard of 1,500 cars' capacity at Belle Isle, near Syracuse.

The Quanah, Acme & Pacific has given a contract to the Texas Building Co., Fort Worth, Tex., to build a 40-mile extension from Paducah, Cottle county, Tex., west to Roaring Springs, Motley county. The maximum grades will be 1 per cent compensated, and maximum curvature 4 deg.

The Riveira Beach Interurban has finished grading work and track laying is to be started at once from Riveira, Nueces county, Tex., to the Gulf of Mexico, 15 miles.

The St. Louis, Chester & Thebes has been incorporated with office at East St. Louis, Ill., and a capital stock of $100,000. The company proposes to operate a railway from East St. Louis to Thebes, through the counties of St. Clair, Monroe, Randolph, Jackson, Union, Alexander, Perry, Franklin and Williamson.

The San Antonio, Uvalde & Gulf has finished grading between San Antonio, Tex., and Fowlerton, and about 45 miles of track has been laid.



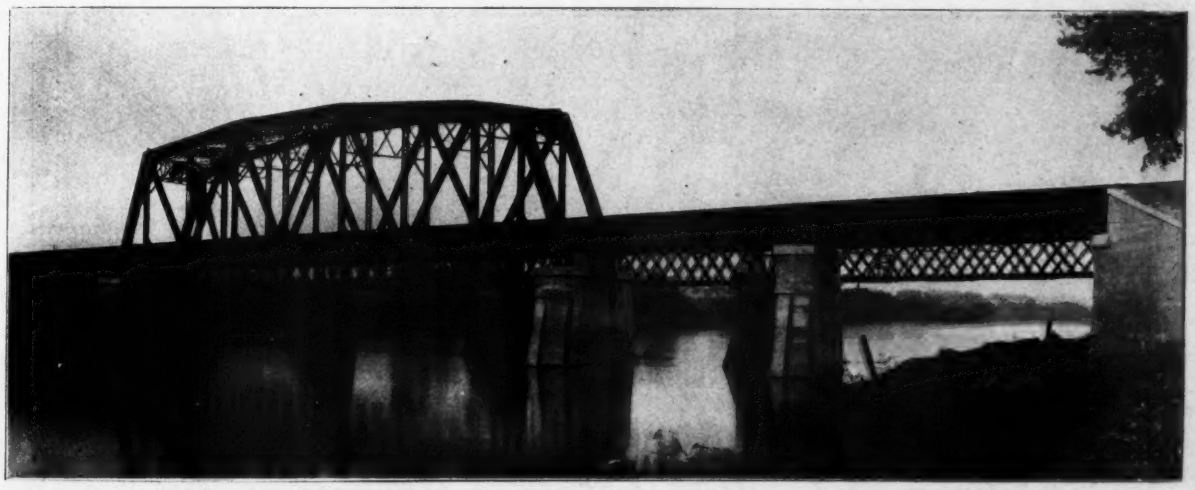
Machine Shop and Power House at Proviso.

MOHAWK RIVER BRIDGE, SCHENECTADY, N. Y.

The Delaware & Hudson crosses the Mohawk river at the north end of the Mohawk Yard on the outskirts of the city of Schenectady, N. Y., at which point the railway company has recently completed a structural steel bridge of five spans. The bridge consists of four girders, two at either end, the center span being a truss.

The new bridge is located parallel with, and about 40 feet southwest of an old bridge, which was erected in 1873. As is shown in one of the illustrations, the former bridge was a single track, deck lattice type of five spans of approximately 105 feet each, with wooden floor. In 1885 it was necessary to strengthen this bridge, and a center truss was added with additional bracing, and these additions made the bridge capable of carrying about Coopers E-35 to E-40 loading.

A new bridge was necessitated by the constant increase in weight of rolling stock. The line carries the very heavy traffic from the coal region and from the west to New England and northern New York and Canadian points. The old bridge was single track, and a double track bridge became necessary on account of congestion on the single track bridge.



New Mohawk River Bridge, Showing Old Lattice Girder Bridge.

The Mohawk river at the point of crossing is about 500 feet wide at normal level. At high water or about 10 feet above normal, the width increases to about 600 feet. If the water rises still higher the river spreads out over the flats on the westerly side and covers a large area.

At normal water level the bed of the river slopes off quite rapidly until a depth of 12 feet is attained. This depth continues nearly uniform to about 200 feet from the south shore. The slope increases rapidly from this point till a depth of about 26 feet is attained 70 feet further on. The 26-foot depth increases to 28 feet about 20 feet further on, and this is the maximum depth. The rise in the river bed is abrupt from this point until a depth of about 12 feet is attained. The slope from this point to shore approximately uniform. The river channel seems to be quite stable, as no perceptible change is noticeable. (The necessity for examining the stability of the channel of a river was shown strikingly on a bridge erected across the Missouri river. That river is noted for the rapid changes which take place in its channel and shores. A railway bridge constructed over this river was laid out with a swing span over the channel. Even before this bridge was entirely finished, the channel had shifted so far as to make the swing span almost useless. This circumstance necessitated construction along the river banks to again force the river back into its original channel.)

Between normal level and high water, a variation of about 20 feet may take place, but ordinarily the rise is about 15 feet. The current at low water is slow, but a slight raise in the level causes a decided change, and at flood height the current in the channel is very rapid.

The river bottom contains dense blue clay and hard pan, and the bed of the stream is strewn with boulders of all sizes. The strata under the river consists of a layer of sand, which decreases from a thickness of 2 or 3 feet near the shores down to the channel where the current is sufficient to keep any sand from being deposited. Beneath this is the layer of hard pan and boulders, into which test holes were bored for 35 feet without striking rock or sand. The strata of hard pan is at least 42 feet thick. Above normal level, the banks of the river are composed of loam, sand and gravel.

The bridge is entirely on tangent, crossing the river at an angle of 62 degrees, this angle allowing the piers and abutments to be set parallel with the flow of the river. The bridge is double tracked, carrying a north-bound and south-bound main, and was designed for Coopers E-60 loading.

The north approach ascends toward the bridge on a .24 per cent grade, which grade continues across the structure. The south approach is on a descending grade of .83 per cent which meets the .24 per cent grade at the back wall of the south abutment. The south grade gives a great advantage to the heavy tonnage coal and other trains, and the tonnage returning south is likely to be light so that in general the grades are well adapted to the traffic.

Substructure.

There are two wing abutments and four piers in the structure, all of plain concrete. The piers are numbered from the south, Nos. 1, 2, 3 and 4. Three test holes were bored to determine the nature of the strata, all three being on the locations of the piers for the center span. Bore holes Nos. 1 and 2 were made at pier 3. No. 1 showed 27 feet of water, 32 feet of hard pan and boulders, 7 feet of fine sand, 5 feet of fine gravel and 2 feet of fine sand. The hole was not penetrated to rock.

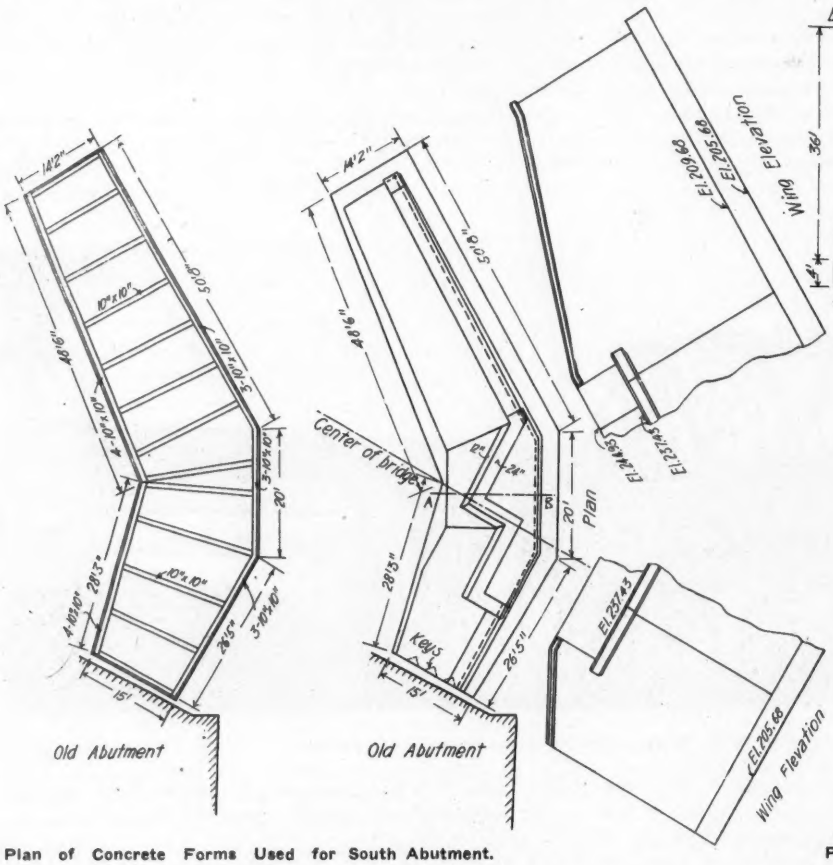
No. 2 showed 20½ feet of water, 2 feet of fine sand and 18 feet of hard pan and boulders. This gave sufficient depth to permit of foundations being bedded satisfactorily, and the hole was bored no farther. Bore hole No. 3 was at the

location of pier No. 2. At this point there was 12½ feet of watet, 3 feet of sand and 35 feet of hard pan and boulders. The hole did not penetrate below the hard pan.

The excavation varied from 4 to 10 feet into the hard pan. A good hard soil was found on the surface of the hard pan after the loose boulders and sand had been cleared away, but the excavation was carried down far enough to prevent any likelihood of scour.

The south abutment has a face 20 feet wide, and wings 50 feet 8 inches and 26 feet 5 inches long, the latter wing at that point coming up against the abutment of the old bridge, which was left in. The height from neat line to base of rail is 36 feet. The back of the abutment is formed by two intersecting faces, instead of three, the lengths pier is 33 ft. x 8 ft. 6 ins. at the top, and 51 ft. x 14 ft. 6 ins. at the base, with a height of 43 ft. from bottom neat line to top of coping. The ice breakers are 30 ft. high, surmounted by coping. The batter on the ice breakers is 4 ins. to 1 ft. The three corners are protected with steel angles. The coping on the ice breakers of piers 1 and 4 is 2 ft.; on piers 2 and 3 the coping is 1 ft. thick.

Pier No. 3 was built in two sections, by sinking two caissons. In order to give a good bond between the two parts 8 old rails were placed in the pier about a foot above the top of caissons. As will be noted on the plans, piers Nos. 2 and 3 are not centered on their footings. The footings project considerably more on the channel sides than on the opposite sides. This was evidently done to equalize the



Plan of Concrete Forms Used for South Abutment.

Plan and Elevations of South Abutment of Mohawk River Bridge.

being 48 feet 6 inches and 28 feet 3 inches, the intersection of these planes being at the center line of the bridge. This design simplified the form work considerably. The batter at the back of abutment is ½ in. to 1 ft. The face of abutment batters 4 ins. to 1 ft., from the footing to a point 10 ft. above. The remainder of the face is vertical. The back wall was poured at same time as abutment, and has a vertical face and battered back. The bridge seat was not made straight on account of the span being on a skew. The footing is 4 ft. thick, with one offset of 9 ins. at the back, 2 ft. from bottom.

The piers are similar to each other in shape and design. They are rectangular with pointed ice breakers, protected by angle facings. The tops of the two channel piers, 2 and 3, are 9x48 ft., the bases being 18x70 ft. Pier 3 is 40 ft. 3 ins. high, and pier 2 is 34 ft. 6 ins. high, from botton neat line to top of coping. Pier 1 is 33 ft. x 8 ft. 6 ins. at the top, and 53 ft. 6 ins. x 16 ft. 6 ins. at the base. The height is 40 ft. from bottom neat line to top of coping. The north

pressure on the foundation, the spans on the channel sides being 240 ft. long, and on the opposite side about 65 ft. The mixtures used in the piers was 1:3:6 for foundations and body, and 1:1:2 for coping and pedestals at top of piers.

The main coping on each pier is 2 ft. thick and forms the bridge seats for the girder spans resting on piers 1 and 4, and for the channel truss spans on piers 2 and 3. Pedestals were placed on piers 2 and 3 to support the end track stringers and girders.

The footings for piers 1 and 3 were made with steps on the top. In piers 2 and 4, the footings had two large keys providing a strong bond between the body of the pier and the footing.

The north abutment has wings 66 ft. and 44 ft. long and is 30 ft. from neat line to base of rail. The depth of footing was gradually decreased towards the ends of the wings. The east wing has three steps, designed to follow the slope of the ground, and thus affording a saving of concrete. The footing of this wing is 2 ft. thick at outer end, and 4½ ft.

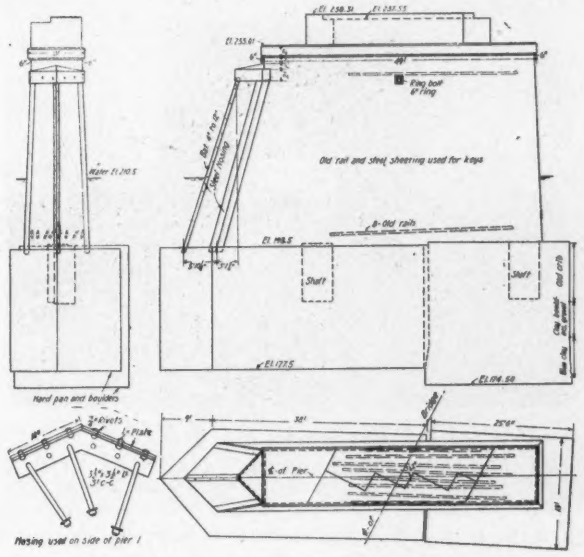
thick where it joins the center portion of the abutment. The mixtures used in both abutments were the same as used in the piers. Excavation for the abutments were made by hand labor and derricks in open pits.

Construction.

Sheathing was necessary for the south abutment on account of the proximity of the Erie Canal, but no sheathing was necessary for the north abutment. The excavated material consisted of sand, gravel and hard pan.

The old bridge, 40 ft. southwest of the new bridge location, gave a very convenient place to lay out a base line. A line was layed out parallel to the new bridge tangent outside of the west rail. The intersection of this line with the New York State Barge Canal center line was located and permanently established. From this intersection the lengths of spans, and positions of cofferdams, cribs, caisson and forms were located.

When work had progressed sufficiently to make measurements on the new center line of the bridge, no appreciable errors in measurements were discovered. Before locating



Mohawk River Bridge.

the piers preliminary soundings were taken along the center line and site of each pier.

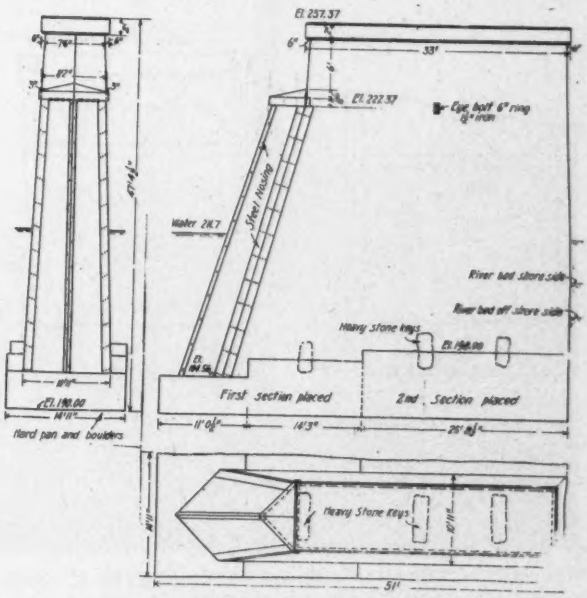
The excavation was started by two gangs on opposite sides of the river August 21, 1911, and these gangs moved ahead and worked on the piers as soon as abutments were completed. The time in which excavations were made and concrete placed shows that the work was pushed energetically.

The excavation on the north abutment was finished October 2d, and concreting was begun October 12th, and finished November 19th. On the south abutment excavation was begun October 5th and finished November 21st. There was a difference of only two days in completing the work on these piers, although there was a difference of seven days in starting the concrete work. This comparison shows excellent organization and the advantage which can be attained by working two gangs on similar work and exciting rivalry between them.

Piers 1 and 4 were completed in about an equal length of time. It required 29 days for excavation and 43 days for concreting on pier 2. On pier 4 the excavation was completed in 25 days, and concreting was completed in 37 days. The excavation on pier 1 was started only five days after excavation was completed on south abutment, and on pier 4 excavation was started 22 days after excavation was completed on the north abutment.

The longest time was spent on pier 3, for which it was found advisable to sink two caissons, the rest of the excavations having been made in open pits. The up-stream caisson was launched November 28; excavation and concreting (on the deck) was begun December 16. Excavation was finished January 5, and only two days were required to finish placing the concrete under air pressure in the caissons. The same organization was used on the down-stream caisson, which was launched January 2nd, three days before excavation was finished on the other caisson. Excavation and concreting on this caisson began January 8; excavation was finished January 28th, and concrete was all in place January 29th.

In order to bring the channel piers 2 and 3 to completion at about the same time, work was started on pier 3 November 28, while work was not started on pier 2 until January



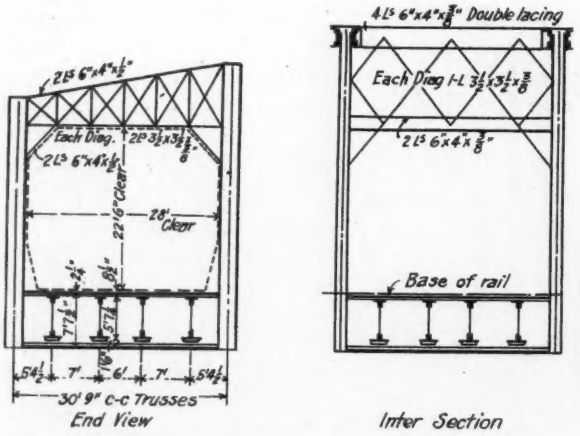
Mohawk River Bridge.

9. The work on pier 3, requiring the longest time was finished almost a month ahead of pier 2. The time required and the date of completion of the different portions of the work show excellent organization and judgment.

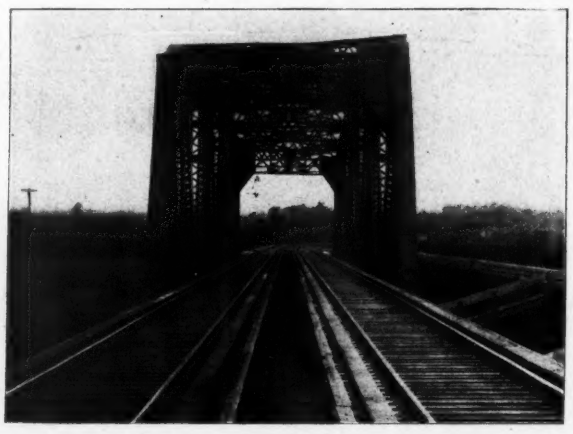
Owing to the nature of the bottom of the river the original ideas of using steel sheet piling for cofferdams, for piers 1, 2 and 4 and dredging for pier 3, were modified as it was impossible to drive wooden guide piles with steel points sufficiently deep to hold the framing for the sheet piling. Railroad rails were driven down and the frame work anchored to these rails by means of cables. The driving of the sheet steel piling with a two-ton Vulcan steam hammer suspended from a derrick boom was not very successful, as it was found that some of the piling would strike a boulder and turn up for a distance of 4 or 5 ft., and in other cases the piling would split and twist in various shapes. It was impossible to pump out the dam when completed; divers were employed and bags of sand were extended around the outside of the piling, and loose horse manure rammed between the canvas and the piling; this method was adopted for the foundation of pier No. 1. For the foundation of pier No. 2, two rows of sheet piling were used with clay puddled down between them. Pier No. 4 had one row of sheet piling and two rows of wood piling in some places

with dams of puddled clay. Even with this precaution it was difficult to keep the dams secure and dry, as the contact of the piling with the boulders would open the joints of the piling. In addition the cribs of the old bridge were encountered and the piling had to be driven through them, cutting logs that were 12 to 18 ins. in diameter which were found to be perfectly sound after forty years of submersion.

It was found impossible to dredge for pier No. 3 as originally intended, and it was then decided to use pneumatic caissons. Owing to the condition of the river bottom at this point and foundation of the old pier, two caissons were used, the large one up stream and the small one down stream. The large caisson rested nearly level on the bottom while the depth of water for the smaller caisson varied from 6 ft. at one corner of caisson to 26 ft. at the other corner, the smaller caisson also landed on the crib of the old bridge requiring cutting it off, under air pressure, the workmen being in water up to their waists. The caissons were built



Sections at Interior and End of Truss Span, Mohawk River Bridge.



End View Mohawk River Bridge.

of 12x12-in. yellow pine timber, 9 ft. deep, decked with 12x12-in. timber, the whole being reinforced by iron rods, the inside sheathed with 3-in. by 12-in. yellow pine plank, all joints being caulked with oakum. A cofferdam of 3-in. by 12-in. yellow pine was built on top of the caissons before floating, and the caissons were sunk by filling the cofferdam with concrete. After excavations were completed the caissons were filled with concrete under air pressure. Above the caissons the cofferdams were connected so as to form a continuous foundation, old rails being used over the two caissons which were 6 ins. apart. One day was lost on account of the disturbance of the wind which was so strong on February 22, 1912, that work was abandoned, the foundations being above water.

The excavation was difficult, as blasting was inaffective, except in a few cases, on account of the condition of the cofferdams. The excavation was therefore made mostly by the use of picks and points.

Concrete was placed in layers of a thickness not exceeding 6 ins., and finished work was allowed to set for at least 72 hours before load was applied. Particular care was taken to secure monolithic concrete, except where construction joints were shown in plans. Where necessary to accomplish this object, the engineer had authority to prosecute the work day and night.

Material for piers and abutments were placed by derricks and buckets, derricks being supported on temporary cribs placed between piers and abutments on either side of the channel span. The abutments and piers were built in lifts of about four feet, building stones and short pieces of railroad rails used for binding each lift.

The concrete next to the forms was spaded thoroughly to get the finer ingredients to the face, in order to get a face of maximum density to exclude water. Holes in the surface were struck down with mortar after forms were removed, and finished concrete was wet down each day for two weeks.

The forms were required to be 2-in. material and dressed lumber, and were firmly held in place by braces or ties. (No forms for massive concrete should be made of less than 2-in. lumber, firmly braced; this fact is evidenced by the many concrete structures with imperfect (usually bulging) faces between the points of support in the forms. And such imperfect lines will appear even when using 2-in. lumber, unless the work is carefully watched and well done.)

The concrete mixture used in the bodies of the piers was class B, a 1:3:6 mixture. The outer faces of the concrete have a finish consisting of a 1-in. thickness of a 1:2 mortar. This finish was placed simultaneously with the backing.

The substructure was built by the Foundation Company of New York. Work was started August 21, 1911, and completed March 9, 1912.

	Cu. Yds.
Dry earth excavation	3,200
Wet earth excavation	1,890
Concrete—	
South abutment	1,069
Pier No. 1	613
Pier No. 2	1,296
Pier No. 3	1,760
Pier No. 4	709
North abutment	860
Total	6,307

Superstructure.

The superstructure consists of four double track deck girder spans and a through double track skew riveted Warren truss with broken top chords. The truss span measures 240 ft. center to center of end bearings. The panels in this span are as follows: One panel 16 ft. 4½ ins., one 18 ft. 9⅞ ins., six panels 31 ft. and one panel 18 ft. 9⅞ ins. The depth of chords at the center is 42 ft., and at the ends is 32 ft. and 36 ft. 10 ins., the difference in height being on account of the skew. The trusses are 30 ft. 9 ins., center to center, the standard distance between trusses having recently been increased to 28 ft. The tracks are on 13-ft. centers, and the track stringers are 3 ft. 6 ins. from the center line of

each track. The track stringers for this truss are the same height and similar in appearance to the girders on the end spans. This construction shows very plainly in the illustration.

The heaviest compression member is the upper chord in panels 5 and 6. The maximum compression to be provided for in this member was 2,175,900 lbs. The section is built up of a cover plate 31x½ ins., two webs 30x⅝ ins., two webs 30x$\frac{11}{16}$ ins., two side plates 18x⅝ ins., two angles 6x4x¾ ins., two angles 6x6x¾ ins., and two flats 6½x1 ins. The smallest member is the chord in the first panel. The maximum tension to be provided for was 347,100 lbs. The section is made up of four angles 7x3½x$\frac{7}{16}$ ins., and one web 18x½ ins.

The following stresses were used in design: Tension, 16,000 lbs.; compression, 16,000 lbs.—70 l/r; shop rivets, 12,000 lbs.; field rivets, 10,000 lbs.; bearing on masonry, 600 sq. ins. The web plates and angles throughout the girders were of the same size and thickness, the cover plates being varied to obtain the desired section.

The depth of floor was not limited to a shallow design. The beams were made in three sizes, using a 91x$\frac{5}{16}$-in. web and 6x6x⅞-in. angles in A, the smallest section. In C, which carries a maximum panel load, the web plate was 91x⅝ ins., with three cover plates. Stiffeners were placed on both sides of girders and stringers.

The standard practice of the company is to use plate girders for spans up to 110 ft. and riveted lattice trusses for spans exceeding 110 ft.

In the design of plate girders one-eighth of the web is included in the net section. Only two cover plates are used at top and bottom, and these are full length of girder.

A provision of 1 in. per 100 ft. is made for expansion in all structures. Spans of over 100 ft. have pedestals of built

General View of Mohawk River Bridge, at Schenectady, N. Y.

lbs. The loading provided for is Coopers E-60, followed by 6,000 lbs. per lineal foot of track. The impact formula used was $\frac{300}{l + 300}$.

The approach spans consist of deck girders spaced 7 ft. center to center. The spans at the north end under the south bound track are 66 ft. 5¼ ins. (girder F) and 63 ft. (girder D) respectively. Under the north-bound track the spans are 62 ft. 9 ins. (girder G) and 63 ft. (girder F). At the south end the length of spans under the south-bound track are 71 ft. 3 ins. (girder A) and 71 ft. 6 ins. (girder C) respectively. Under the north-bound track the spans are 74 ft. 11 ins. (girder B) and 71 ft. 6 ins. (girder C).

The dead loads used in the design of girder spans was as follows:

	Track	Steel	Total
Girder A	400	1,080	1,480
Girder B	400	1,140	1,540
Girder C	400	1,080	1,480
Girder D	400	980	1,380
Girder E	400	1,040	1,440
Girder F	400	980	1,380

Girder A, span 71 ft. 3 ins., was built up of one web 84¾x $\frac{7}{16}$ ins., four angles 8x8x⅞ ins., two cover plates 20x$\frac{11}{16}$ ins., and two cover plates 20x⅝ ins., giving a net section of 44.88 section, and pins at each end. Spans of 90 ft. and over have nests of turned rollers at one end, running between planed surfaces, and the rollers are made at least 3 ins. in diameter. Spans under 90 ft. have friction and masonry plates under one end.

The truss was given a camber by making the panel lengths of the top chords larger in the proportion of ⅛ in. to 10 ft.

The following extracts from the specifications for structural steel give a very good idea of the strict requirements for the material:

"Sole plates, bed plates, rollers and pins are to be of medium-hard steel. Rivets are to be of rivet steel All other parts are to be of soft medium steel. Structural steel shall be acid or basic open hearth and shall show a chemical content not exceeding phosphorus .08 of 1 per cent for acid steel and .04 of 1 per cent for basic steel. Sulphur shall not exceed .05 per cent. Medium-hard steel is to have a tensile strength not less than 65,000, nor greater than 75,000 lbs. per sq. in., and an elastic limit of not less than one-half the maximum strength. The elongation on an original length of 8 ins. shall be 22 per cent for plates less than ¾ in. thick and for shapes, and a reduction of 20 per cent for plates over ¾ in. thick and a reduction of area at point of fracture of 40 per cent for plates less than ¾ in. thick and for shapes, and a reduction of 35 per cent for plates ¾ in. thick. Medium-hard steel shall bend cold 180 degrees to a circle

whose diameter is equal to 1½ times the thickness of the test piece, and when quenched from a bright red heat in water at 80° Fahr., it shall bend 180 degrees to a circle whose diameter is three times the thickness of the test piece without sign of fracture on the outside of bent portion.

"Soft medium steel must show a tensile strength of not less than 55,000 lbs. and not more than 65,000 lbs. per sq. in., with an elastic limit of not less than one-half the maximum strength." . . . . . .

Erection

The plate girder spans were riveted complete at the shop and placed in position with a derrick car. The channel span was erected upon false-work placed in the river with supports under each floor beam, using a derrick car for placing the steel work.

The deck consists of creosoted yellow pine ties 9x9 ins. x 10 ft. long, notched to 8½ ins over girder and track stringers. Yellow pine creosoted guard timbers 6x8 ins., notched 5 ins. deep over ties, are placed outside of rails. Inside guard rails are used on the bridge end approaches. Tie plates are used under rails.

Weight of North Span	77,100 and	69,000 Lbs.
Weight of Second Span	66,000 and	66,000 Lbs.
Weight of Channel Span		1,448,000 Lbs.
Weight of Fourth Span	84,000 and	84,000 Lbs.
Weight of South Span	92,400 and	80,000 Lbs.
Total		2,066,500 Lbs.

The extreme north spans of girders were erected in two days, the adjacent spans in one day; the steel work for the through span was erected in about thirty days, the riveting of same occupying about 28 days. The remaining girder spans were erected in about one day each.

The design and construction of the Mohawk River bridge were under the supervision of George H. Burgess, chief engineer of the Delaware & Hudson Co., and we are indebted to him for the information, plans and illustrations given in this article.

The Northport & Western was incorporated in the states of Mississippi and Louisiana to build from Gulfport, Miss., west to Covington, La., 65 miles. W. H. Hordy, president, Gulfport.

A contract has been given to the Utah Construction Co., by the Oregon Short Line for laying second track between Kemmerer, Wyo., and Fossil; also between McCammon, Idaho and Renfro.

Track laying has been started by the Oregon-Washington R. R. & Navigation Co. on the line from Ayer Junction, Wash., northeast towards Spokane. This work will be finished by December 1 and trains will be in operation into Spokane by the summer of 1913.

The Reid Newfoundland is building a branch from St. Johns, Newfoundland, south to Trepassey bay. Grading has been finished on 80 miles and track has been laid on 70 miles. The company is also building a branch from Broad Cove north to Hearts Content, about 35 miles. Grading has been finished on 12 miles, and track has been laid on 10 miles.

The Utah Light & Railway Company has under consideration plans for building from Salt Lake City, Utah, to Bountiful, about 8 miles. If the company decides to build the line the work will be carried out with the company's forces. J. S. Wells, general manager, Salt Lake City.

The Waycross & Western is now operating 15 miles of the line under construction from Waycross, Ga., southwest via Sirmans and Milltown to Rays Mill, 51 miles. The company is building the line with its own forces and expects to develop a traffic in lumber, cross-ties, cotton and fertilizer. A. K. Sessoms president, Waycross.

ROUND TIMBERED BRIDGE AT CONCRETE, WASH.

At Concrete, Washington, on the line of the Baker River & Shuksan R. R., is located a bridge which is probably the only one of its kind in this country.

The Baker River & Shuksan is a small railroad in the northwestern corner of the state of Washington. The bridge described and illustrated herein was necessitated in the construction of a track to reach a lime rock quarry, which is the source of supply of the raw material for the Superior Portland Cement Co.

As is shown in the illustrations, this bridge is of unique type. The entire structure is made of round logs, just as they came from the trees, except that the bark was removed to prevent rot.

The bridge has a total span of 185 feet, with approaches

Bridge Site, Round Timbered Bridge at Concrete, Wash.

about 220 feet in length, making the total length approximately 625 feet. The approaches are similar in nature to the timber trestle approaches to permanent bridge structures. These approaches, however, are made up mostly of frame bents, as the soil is not very deep and is underlaid by solid rock.

The span across the river is on a tangent nearly all the way, a curve starting a few feet from one end. Both approaches are on curves.

The lower deck of the structure rests on timber piers. These piers are set in benches in the rock in the sides of the canon. The shape of the piers is triangular, with the point resting on the foundation, a construction similar to the falsework used sometimes in supporting the steel when erecting across a deep channel.

The face of the canon, at the bridge location, has nearly perpendicular walls of limestone on both sides. The illustration showing the bridge site before work was commenced gives an idea of the difficulty of carrying out the work.

The inclined pier timbers at either end of the span are round logs of a minimum thickness of 14 inches at small

end, and are 90 feet long. The shelves in the rock on which they rest are 15 feet above the high water mark. No masonry was required, it being necessary only to blast out the rock and level up the shelf floor. The perpendicular timbers in the piers are anchored to the face of the canon wall.

The lower chord of this structure, or the supporting timbers across the span, is made up of 8 logs which have a minimum diameter of 40 inches at small end and are 92 feet in length. Upon these 8 logs the main part of the bridge is built. The stresses from the structure above are distributed equally on these lower chords at about the fifth points. The bearings of the structure above are transmitted transversely by a round beam resting on all the lower chord members. The main compression members of the superstructure are vertical, and are very heavily braced. Above the floor the construction is similar to an ordinary trestle. The height of the vertical members is approximately 75 feet, so braced that the column action on these verticals acts on a length not over 20 feet. The deck of the bridge is 185 feet above normal water level.

In all the work there is no iron, other than the drift bolts, spikes, and doll pins used in anchoring. Neither are there any sawed or mill made timbers, which in itself is worthy of note. Every piece of timber is just as it came from the tree, excepting that the bark was removed to prevent rot, and it was all cut within a mile of the bridge. There are approximately 600,000 board feet of timber in the structure.

The method of construction was as follows: The grade was completed, and track laid up to the west approach of the bridge. All timbers were framed in the woods, and loaded directly on logging trucks and hauled to the bridge site, where they were unloaded and swung into position by means of a traveller suspended over the bridge, and operated by a donkey engine located at the east approach.

As shown in the illustrations, the net span was reduced to about 80 feet by the diagonal posts running from the

Round Timbered Bridge on the Baker River & Shuksan R. R.

Lower Deck of Round Timbered Bridge Partially Completed.

Second Deck of Round Timbered Bridge.

solid rock at each side of the river bank. These diagonal posts were of about 24-inch diameter fir timber. The tops of bents formed by these posts were anchored from each side by heavy timbers dapped into caps and thoroughly spiked, and the land end thoroughly anchored into solid rock. These bents were temporarily held in position by cables strung across the river. On top of this sub-structure was placed 4 ft. fir logs, which were dapped and connected up with the sub-structure. Having the sub-structure in place, the superstructure consisted of a double-deck trestle, with the ordinary approaches on either side leading to same. The whole structure was thoroughly sway-braced, and showed very little vibration when the trains were operated over it, and has proven very satisfactory for the purpose for which it was constructed.

At any future time, this structure can serve as false work for the construction of a permanent structure. This work was handled throughout by following the logging methods, which are in vogue in the west. Two donkey engines were used, and no difficulty was encountered in handling the big timbers.

Mr. Archibald S. Downey, consulting engineer of Seattle, Wash., designed the structure, and it was built under his supervision by the Reitze, Storey & Duffy Engineering Co., Seattle, being finished in August, 1909. We are indebted to Mr. A. S. Downey, consulting engineer, and E. P. Lucas, general manager of the Baker River and Shuksan R. R., for the information and illustrations given herein.

Upper Deck Completed.

REPAIRING HALSTED STREET VERTICAL LIFT BRIDGE.

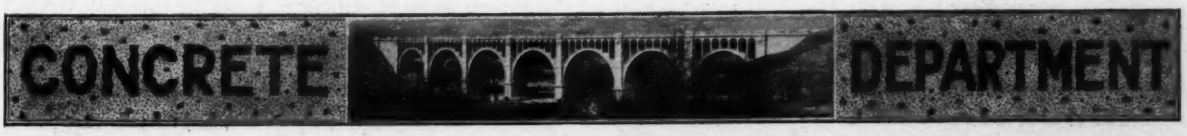
The Halsted street vertical lift bridge over the Chicago river was put into service in 1895 and has been in use since that year. Recently it became necessary to renew the lifting cables and the anchor bolts on which the counterweights were hung. The bridge was taken out of service, all traffic closed and the work pushed as rapidly as possible. The method of renewing the cables and anchor bolts was to first remove the ballast weights from the deck of the bridge in order to make the span as light as possible and then raise the span up so that the counter weights would rest on their supports at the bridge level, this requiring that the span should be lifted to the maximum height which is approximately 125 feet. The span was light enough without ballast so that it was possible to disconnect part of the counterweights and renew these while the other counterweights balanced the span.

The anchor bolts originally were two inches in diameter, but these had rusted away until in some places they were found to be not more than one inch in diameter. Some difficulty was experienced in getting the rust entirely out of the holes in the counterweights so that new anchor bolts could be inserted.

The first operation in renewing the anchor bolts was to cut off the eye on the top and then drive the remainder down through the hole in the counterweights. The excessive rusting of these bolts and counterweights is shown by the fact

that a full bucket of rust was taken out of some of the holes. Afterwards the old anchor bolts were cleaned out as far as possible or to make them large enough for the new anchor bolts by churning with different sized rods and using a mandrel. The new cables were pulled up by fastening them to the old ones and taking a new hitch at the top.

The cost of renewing these parts was rather high on account of working both day and night, Sundays and holidays. Traffic was blocked for about two weeks and the cost for the labor alone was $6,000. The Halsted street lift bridge was the first vertical lift bridge constructed in this country and is a structure of historical interest.



Esthetic Design of Bridges.

IN the past very little effort or money has been expended in carrying out even the elementary artistic principles which should govern bridge design. In general the watchword has been, "A structure which will serve the purpose at the least cost to the owner." All other considerations except those legally enforced have in general been ignored. The practice of competitive bidding and designing has done much to remove esthetics from design. Nearly all the bridges in the city of Chicago, the greatest railway center, including the elevated structures which are the worst offenders, bear out these statements.

There are of course conditions to be met in some cases which make impossible any consideration of beauty in the design of a bridge. These isolated cases, however, should not be cited as proof that esthetic design is impossible, or uncalled for.

It is a fact the public has its artistic tastes developed by seeing at various times structures which depart from the common, financially economical structure, in having some lines of beauty which show that something besides strength alone was sought in the design. It does not require a man of exceptional intelligence to note artistic points in a bridge; even the most ignorant person recognizes very readily that which is pleasing to the eye. People see bridges over lagoons and rivers in parks, where the bridge besides being designed to carry the loads, was designed to harmonize with the surroundings and to render the scene more beautiful if possible. This at once excites the artistic tastes and people wonder why the elevated structure of the A. B. & C. Ry. over the street on which they live, could not have been designed and constructed in such a manner as to make the structure one of beauty rather than the ugly structure that greets them every time they walk down the street.

At the present time we are just entering a period, when sooner or later the public will demand that bridges, elevated structures and viaducts be designed and constructed so that they shall add to, rather than detract from the beauty of the surroundings. That this can be done is shown by some of the track elevation structures built in the city of Chicago, and suburbs, within the last few years. In most cases these structures are the results of demands of the Park Commissioners that bridges over boulevards, the connecting links between parks, shall be of a design in keeping with the surroundings. We also note with satisfaction that in many cases the railroad companies are entering this work with the idea in mind that an artistic structure even at an increased cost is of as much credit and benefit to the road as to any one else.

By the use of concrete, esthetic considerations can be more readily carried out than by the use of steel and ornamental iron. The very nature of the material, its plastic properties when first made, is suggestive of this fact.

The fundamental principles governing esthetic design are:

(1) *Symmetry.*—Absolute symmetry produces an effect which is always pleasing to the eye, and should be obtained if possible even at increased cost. If a bridge is unsymmetrical about a middle point for some reason which is apparent to the observer and is otherwise of an artistic nature, the impression created is also pleasing but in any case not as much so as if the structure possessed perfect symmetry.

(2) *Style and Outline.*—A bridge to be artistic should conform as nearly as possible with the surroundings. Bridges in parks and cities should have a graceful and finished appearance rather than a bold coarse and unfinished appearance such as a structure located in the mountains or heavy forest should possess.

The arch possesses the most artistic outlines for a bridge. Bridges with chord members parallel and those made up wholly of a combination of members with straight lines are not nearly so pleasing to the eye.

Concrete lends itself readily to arch design and construction, and to such forms as break the monotony of straight lines. For esthetic reasons concrete is the ideal material for bridge building.

(3) *Proper Proportions of Parts.*—In order to produce a pleasing design the various parts of the structure should be of such proportions and dimensions as to be in harmony with the structure as a whole.

(4) *Ornamentation.*—The aim of proper ornamentation should be not to change the general character of a structure, but to apply it in such a manner as to bring forth the purpose of the design, by contrasting different parts.

By ornamenting the piers, arch rings and otherwise decorating parts of structure to emphasize their importance we add to the esthetic appearance, but in any case an overloading of ornaments does not produce the desired results. Just how much ornamentation and the proper sizes of ornaments to be used is a matter which requires careful study and the best of judgment.

With the above principles in mind it requires very little study to find that the bulk of our bridges are by no means artistic, some of them being positively ugly.

A concrete bridge can be moulded with pleasing lines at a slight increase in cost over a structure with plain straight lines. The ornamentation can be of concrete, poured at same time as rest of structure, if not too ornate. Steel

girder bridges are in many cases covered by concrete to protect them from rust. By slightly modifing the lines of the structure with the concrete, it can be rendered artistic. The surface of the concrete can be treated either by rubbing, brushing, tooling or sand blasting so as to remove the forms marks and produce a smooth surface or expose the aggregates thereby giving color to the structure and adding to its beauty.

The Independence Boulevard Bridge of the B. & O. Ry. illustrated and described in this issue, is a fine example of what can be done in the way of esthetic design by a combination of structural steel and concrete. This structure is a credit to all those concerned in its construction and it is hoped that in the future more attention will be given to the artistic lines of structures so as to eliminate the ugly, unpleasing structures so common at the present time.

Independence Boulevard Bridge, B. & O. C. T. R. R.

A. M. Wolf.

The B. & O. Ry. is at the present time carrying out, in part, its program for track elevation of its Chicago terminal property, the B. & O. Chicago Terminal R. R. on the west side of Chicago. This work embraces many steel bridges protected by concrete over streets crossed by the tracks, which are used by several other roads having trackage rights on the B. & O. C. T. R. R. The largest and most elaborate of these structures is the bridge over Independence Boulevard, between West Taylor and Fillmore streets. This bridge, which spans one of the finest boulevards of the West Chicago Park system, was designed and executed with the idea in mind that it should add to, rather than detract from, the beauty of this boulevard. The adopted design, an ideal one for the location, is a steel structure, encased in concrete so as to give the appearance of a masonry structure of comparatively flat arches with massive but simple and artistic treatment of portals. This design is in accordance with an ordinance passed in August, 1911, by the West Chicago Park Commissioners.

Roadway Span, Independence Boulevard Bridge.

General Location.—The bridge, a four track, nine span structure, located on tangent, crossing the boulevard at an angle of 90° 33′ with the center line, is 42 ft. wide center to center of fascia girders and 250 ft. 10 in. long between abutment faces. The distance between street lines is 250 ft., the face of abutments being 5 inches back of street line. The bridge spans a wide sidewalk and depressed roadway at each end, and a wide parkway between roadways.

Boulevard Subway—The dimensions, grades and details of subway as given in the following are in exact accordance with the ordinance.

The east walk, 24 ft. wide between curb and abutment, has a drop of about 11 inches from abutment to curb. The west walk is 31 ft. wide and at same elevation as east walk and has a 11 inch pitch toward the curb. The walks are of cement construction, 5 inches thick, being 8 feet wide on approaches and in subway extend from abutment to curb.

The east driveway, 32 ft. wide between curbs, is depressed 2 ft. below level of walk at the curb, in order to give 13 ft. clearance at the crown of roadway. The west driveway is exactly similar in all respects to the one on the east. The roadways are 32 ft. wide only in the block between Fillmore and Taylor streets, beyond these points they are 40 ft. wide, center line coinciding with center line of subway drive.

The roadways will be paved with asphalt on a Portland cement concrete foundation 6 inches thick. The curbs are of granite concrete 8 ins. thick and 24 ins. deep where less than 12 ins. of curb shows above gutter. When more than 12 inches of curb shows above the gutter, the curb is 12 ins. thick at top and 14 ins. at bottom, and 5 ft. deep.

At the top and foot of slopes of approaches the change in grade of pavements is made to conform to a vertical curve which is tangent to intersecting grades at points 20 ft. from their intersection.

The parkway, 131 feet wide, covered by five spans of nearly

identical dimensions, is crowned 2 ft. 6 in. from curbs to center line, the clearance at this latter point being 8 ft. 6 ins. The parkway under the bridge will be covered with 6 in. of crushed limestone bonded with screenings.

All cement walk curbing, paving, electric conduit and sewer work was done by the railroad company according to standard specifications of the West Chicago Park Commissioners.

Ordinance Relating to Bridge Proper.

"The tracks shall be carried across the boulevard on steel bridges of nine spans. Rows of columns supporting said bridge shall be placed parallel with * * * west line of boulevard.

"The width of superstructure shall be sufficient for four elevated railroad tracks, but not to exceed 56 ft.

"The steel work shall be painted a light color selected by the Engineer of the West Chicago Park Commissioners and shall be repainted whenever required to present a neat appearance.

"The superstructure concrete portals and abutments and all walks within the right of way lines of the B. & O. C. T. R. R. Co. across Independence boulevard, shall be forever maintained and kept in good condition by the R. R. Co.

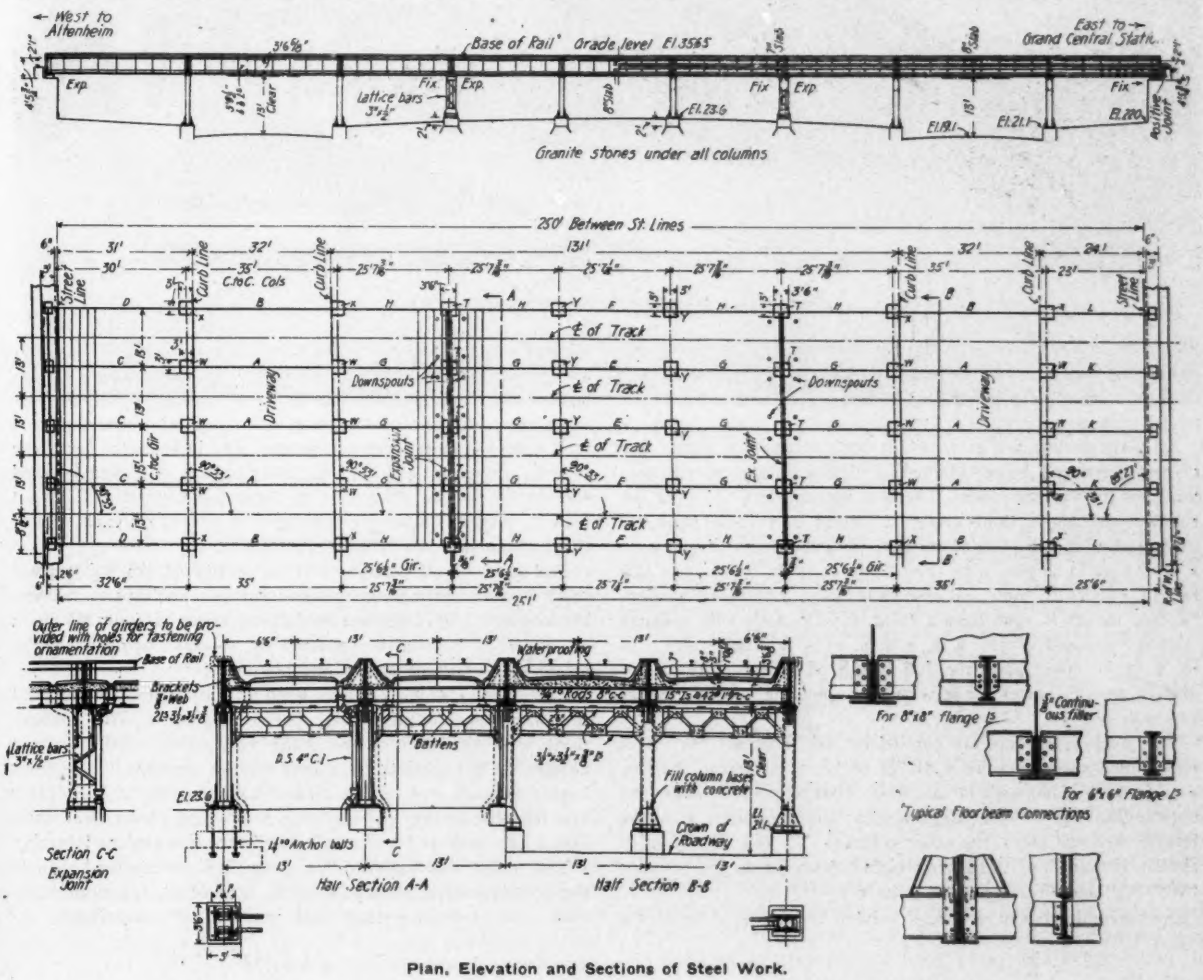
"The girders and masonry of the north and south portals of the subway shall be ornamented and constructed according to designs submitted by the Commission.

"The floor of the superstructure shall be so constructed as to prevent water, dirt, oil or other substance from dropping upon the subway beneath.

"The retaining walls and abutments shall be built of concrete and shall be finished smooth and show no marks of the form. The retaining walls and abutments shall be constructed along the right-of-way lines east and west of the boulevard a sufficient distance and of sufficient height to prevent the loose materials from washing or falling upon the sidewalks."

Abutments.

The abutments are of concrete of a 1:3:5 mixture except the bridge seats which are a 1:2:4 mixture. The faces of abutments are vertical and the coping at the bridge seat is omitted; this is a departure from the standard practice of the road, the abutments being originally designed with batter and coping but changed to conform to the architectural design of portals. The bridge seat is 4 ft. 5¾ in. below the base of rail. The backs of abutments are battered, the width at the top of footing being 0.45 of height above the footing. At the north end of each abutment is a straight wing-wall with vertical face, and battered back and top slope of 1½ to 1. Wing walls are reinforced with ¾ in. round bars 12 in. centers both ways, near face and back. At the south side the abutments join with retaining walls on the right of way line parallel with center line of tracks. The top width of wall is 18 inches and the face has a batter of 7 inches. The abutments were to have been placed with coping and base of wall at street line, but in order to carry out the architectural design, the vertical faces of abutments were set back 5 inches from street line.



Plan, Elevation and Sections of Steel Work.

Structural Steel Design.

The bridge consists of 9 spans of five longitudinal plate girders each, spaced 13 ft. centers transversely, carried on steel columns of a built-up I section. The two roadway spans are 35 ft. center to center of columns, the intermediate spans about

Independence Boulevard Bridge, B. & O. C. T. R. R.

25 ft. 7¼ in., the east end span 24 ft. 6 in. and the west end span 31 ft. 6 in., center to center bearing. The concrete track floor is carried by 15 in. 42-lb. I-beams placed transversely between girders.

All plate girders are 3 ft. 9½ in. back to back of angles, the necessary strength being obtained by varying flange and web sections for the various spans. The long span girders "A" over the roadway are 35 ft. 0 in. center to center of columns and are composed of a web plate 45 in. x ¾ in. and flanges of two 8 in. x 8 in. x ⅝ in. angles, with three 18 in. x ½ in. covers, one full length, one 25 ft. long and one 19 ft. long. The fascia girders "B" for the 35 ft. span have a 45 in. x ½ in. web, with a flange section composed of two 6 in. x 6 in. x ⅝ in. angles and a 16 in. x ⅝ in. cover plate the full length of girders. The other girders are of shorter spans with correspondingly lighter flange and web sections.

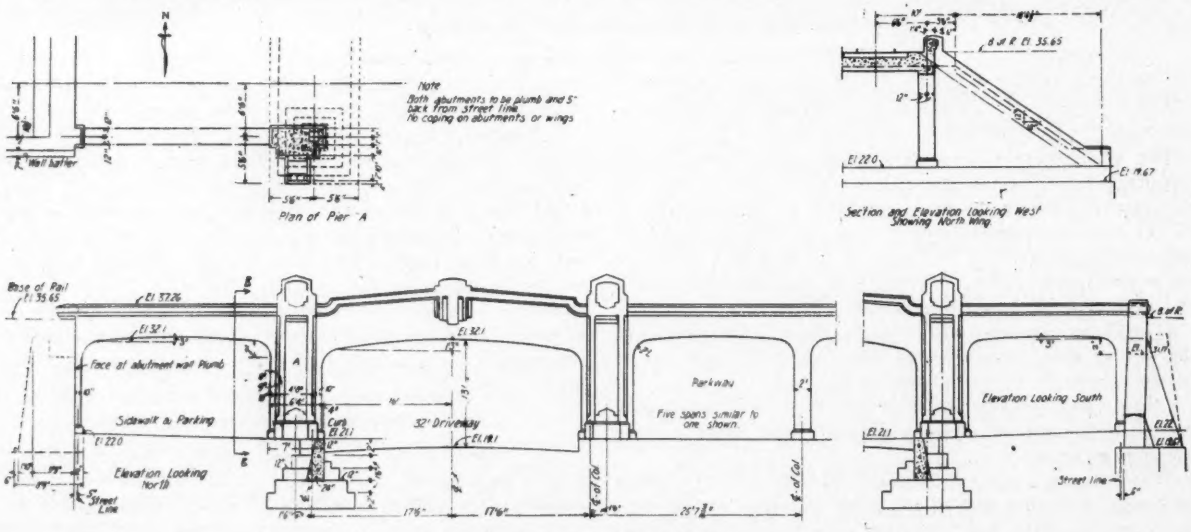
The roadway girders are carried by steel columns "W" built up of four angles 3½ in. x 3½ in. x ½ in. riveted to a 12 in. x ½ in. web plate, with 12 ins., 35-lb. channel riveted across the outstanding legs of the flange angles; these columns have the largest sectional areas, the other columns "X" and "Y" being of similar section, but of lighter weight. Base plates for columns "W," "X" and "Y," are 30 in. x 32 in.

At every third bent a special column is used to provide for expansion connections. These columns or towers "T," as they are called, are composed of two built up I sections 18 in. centers latticed together across the backs of angles. The I sections are composed of a 15 in x ½ in. web with four angles 4 in. x 4 in. x 7/16 in. riveted thereto. The base plates for these towers are 38 in. x 30 in. At these towers one span is fixed and the end of the other has an expansion connection. Two 4 inch C. I. downspouts for drainage are placed on each side of these expansion joints between girders.

The bases of all columns rest on granite blocks 3 ft. square and 2 ft. deep, resting on concrete footings. The tops of columns are connected by a transverse latticed strut of four 3½ in. x 3½ in. x ⅜ in. angles connected by a single lacing of angles at sides and battens at top and bottom.

The 15 in. x 42 lb. I-beams used as floor beams are spaced 1 ft. 9 in. centers longitudinally between girders. The connections with the girders are made very close to the bottom flanges of the girders as shown in the sections. The floor beams at each end of the girders and the one at the center are framed to the girders with a bracket connection composed of a web and two angles, to brace the girders laterally.

The bridge was designed for Cooper's E-50 live load with 50 per cent impact, according to the B. & O. R. R. specifications of 1904. All steel in contact with concrete was unpainted. All


Note
Both abutments to be plumb and 5" back from street line.
No coping on abutments or wings
Plan of Pier "A"
Section and Elevation Looking West Showing North Wing
Elevation Looking North
Elevation Looking South
Five spans similar to one shown.
32' Driveway
Sidewalk & Parking
Parkway
Street Line

Architectural Elevations and Details.

An Ornamental Steel Structure

other steel is to be given a coat of paint of light color satisfactory to Park Commissioners.

Concrete Bridge Floor.

Upon the floor beams is placed a reinforced concrete floor slab 8 inches thick at the center line of tracks at middle of roadway spans and the center span. From these points the slab slopes 1 inch toward downspouts at expansion points and toward ends of bridge where the thickness is 7 inches. The concrete floor is carried up around the girders to top flange as a protection to steel, thus forming a trough section for each track. The slab also slopes transversely from the center line of track to a point near the longitudinal girder where the thickness is 7 inches.

The concrete slab is of 1:2:4 mixture, reinforced with ¾ in. round corrugated bars spaced 8 in. centers transversely. The top of slab is waterproofed by the membrane method. The concrete was mopped with hot asphalt and then a layer of tar or asphalt paper laid thereon and top coated with asphalt. Upon this was placed a 3 inch layer of concrete composed of one part cement and six parts of crushed limestone varying from dust to ½ in. stone. Six inches of crushed stone ballast is used under ties, making the base of rail about 1 ft. below the tops of concrete on fascia girders.

Concrete Portals and Ornamentation.

General—The portals of this subway are of concrete so placed as to mask the steel girders and give the structure the appearance of a series of nine arches of very small rise, in fact very nearly flat, with fillets of short radius at columns or piers.

Roadway Spans—The roadway arches are the largest and very properly the most ornate. The main portion of columns or apparent piers of roadway arches project about 16 inches beyond face of arch with sloping buttresses projecting about 3 ft. beyond the main portion. The main portions of these buttressed columns are carried up so as to be higher than top of arch. At the top of columns a medallion of concrete projects 3 inches beyond the face. The architect's elevation of sidewalk, roadway and parkway arches and section B-B show the details of these columns. The main portions of column are reinforced with ¾ in. round rods vertically at corners, wrapped with No. 23 triangle wire mesh. The buttresses are reinforced with ¾ in. rods at corners parallel to slope of face and tied into column with ⅜ inch round rod stirrups.

The roadway arches have a fillet of 2 ft. radius at the columns and a rise of about 15 inches above the top of the fillet. The coping at top of arch projects 4 inches beyond face of same. At the crown the coping merges with a projecting medallion somewhat more elaborate than those on piers. The steel girders are wrapped with No. 23 gauge A. S. & W. Co. triangle mesh, to hold concrete, and prevent expansion and contraction cracks.

Sidewalk and Parkway Spans.—The sidewalk spans and the five parkway spans have a 2 ft. radius fillet at junction with columns and a very small rise of about 3 inches above this. The coping for these arches is same as for large arches, but the top is carried across the bridge, level. The steel columns, encased in concrete, are 2 ft. square and unornamented. Three-quarter inch round corrugated bars are placed at corners of columns and wire mesh wrapped around them. The fillets are also reinforced with bars placed at 45 degrees. (Corners and edges of all parts of structure have a bevel of ¾ inch.)

Construction of Portals.

Concrete—The concrete used in the columns and arches was a mixture of one part Universal Portland cement and five parts of crushed limestone varying from ½ in. to dust, no sand being used. Special care was exercised by the concrete foreman to see that all concrete mixed was of same proportions and consistency so as not to have varying colors in different parts of the work. No exact specifications as to mixture were issued, the matter of best mixture being left to the concrete foreman on the job.

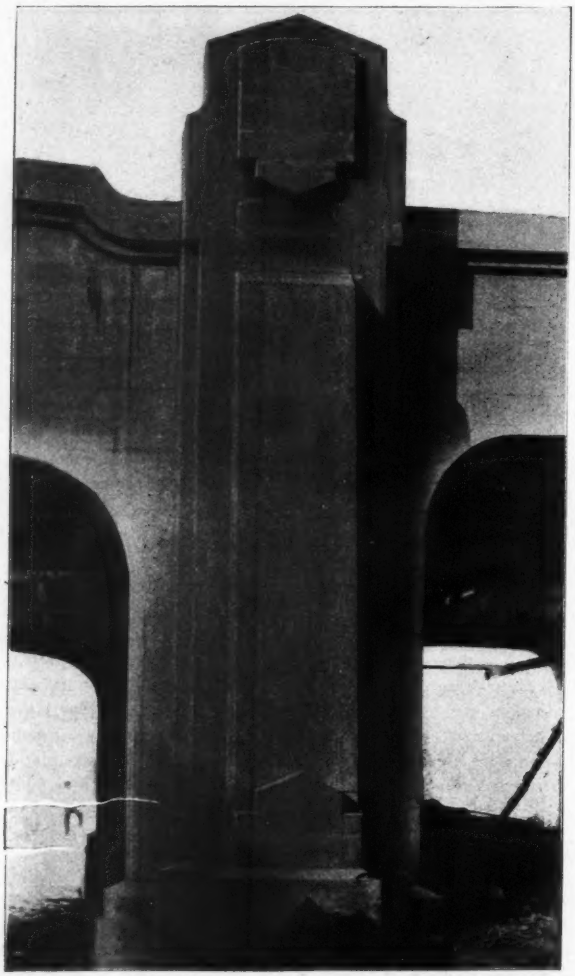
Forms—The forms used were of dressed lumber, but due to frequent use it was somewhat warped and not in the best of condition; but the results obtained in the finished structure are very good in spite of this. The forms for concrete covering of fascia girders were supported or hung from steel work of bridge and also by struts and braces to ground.

Placing Concrete—The concrete for all columns was placed before any concreting was done on arches. The large columns were poured to the top in one operation, a ledge being left at junction with arch fillet. The smaller columns were poured to

the bottom of fillets of fascia arches or girders. The roadway arches were poured separately as were the sidewalk spans and the parkway spans next to roadway. The intermediate section of three spans was poured at one time with an expansion joint at ends at the points where the expansion joints in steel work occur. Concrete was spouted directly into forms from a mixer mounted on a flat car.

No special facing was used in placing concrete, a good surface being obtained by thoroughly spading the concrete next to the forms. The small size of aggregate used was responsible for the fine surface obtained, very little difficulty being experienced with pockets or hollows in face.

Finishing Surface—After the forms were removed and concrete had seasoned and dried out for a few days, the lips and



Ornamental Details of Buttressed Column, Independence Boulevard Bridge.

ridges due to forms were chipped or filed off with chisel, coarse file or rasp. The surface was then wet and rubbed with a coarse carborundum brick until the surface was fairly smooth. After this a thin wash of cement and sand was applied and left to dry. The final rubbing was done with a fine carborundum brick until all of the cement wash had disappeared and the surface was as smooth as possible. All concrete was treated in this manner, including faces of abutments.

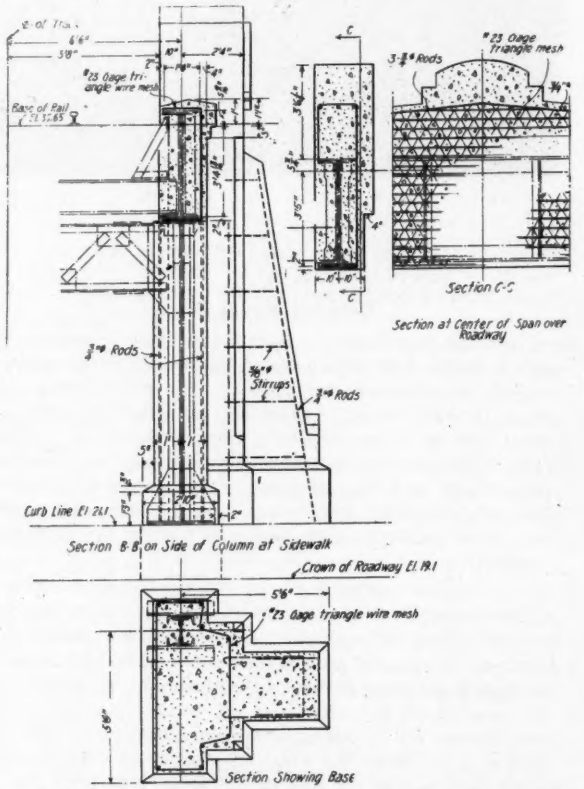
The advantage of this kind of finish is that the surface is a grayish white, is much lighter than can be obtained by any other method of treatment with the same kind of materials.

Comments.

The only faults to be found in the structure which has just been completed are small cracks in concrete over the columns at joints between steel girders. These are due to the fact that concrete which is unreinforced save for wire mesh, is continuous over supports and the steel girders are not, and any deflection or movement in girders tends to crack the concrete. Otherwise the structure shows excellent workmanship and design, and stands out in happy contrast to the elevated railway structure over the boulevard a few blocks north with its attempted but poorly executed ornamentation.

The steel work was designed by the bridge department of the B. & O. Ry., W. S. Bouton, bridge engineer, F. L. Stuart, chief engineer and fabricated by the Jones & Laughlin Steel Co.

The general design of portals and ornamentation was executed by Mr. F. E. Lockwood, architect, Chicago, Ill., for the B. & O. R. R. The details of concrete portals were completed by the company under the direction of L. G. Curtis, district engineer, Chicago. The concrete work was carried out by company forces under the direction of Peter Olson, concrete foreman.



Details of Reinforcement for Buttressed Column and Fascia Girder.

TEMPERATURE CHANGES IN CONCRETE WHEN SETTING.

A paper read by W. D. Maxwell before the Iowa Engineering Society sets forth some interesting and important data on the temperature of concrete during setting. Tests were made during work on Des Moines River concrete bridge. The observations were made in various parts of piers and abutments composed of 1:3:6 concrete, with thermometers placed in pipes set in concrete. The points where readings were taken were from 3 to 10 ft. from surface and face of concrete. The temperatures recorded show an increase of 15 degrees to 20 degrees F. above temperature at time of pouring, in the concrete mass during setting, the maximum being reached in 7 to 10 days after pouring. Then the temperature falls, the rate depending on outside temperature. This rise in temperature was shown to be substantially the same, regardless of outside temperature, some of the tests being made in freezing weather and others during summer.

The Signal Department

NEW SYSTEM OF SIGNALING.

An invention, having for its object the prevention of railway accidents through collisions of trains, and for the giving of audible and visual signals of the approach of trains to level crossings or other danger points, has recently been patented by Frederick Patterson, of the headquarter staff of the South African Railways, according to the South African Railway Magazine. Associated with Mr. Patterson in patenting the invention were T. E. James and W. B. Varian.

As will be seen from the drawings, the method by which the invention is worked in no way affects the "permissive" system of working followed in South Africa, while it retains all the advantages in regard to safety that are obtainable under the "Absolute Block" system. The outstanding feature of the invention is that it is entirely automatic in its action, and is not dependent upon the human element to keep it in order, except in regard to maintenance. The principle of working here described is what is known as "open circuit," and unless there is actual danger of collision through two trains being allowed to occupy the same sec-

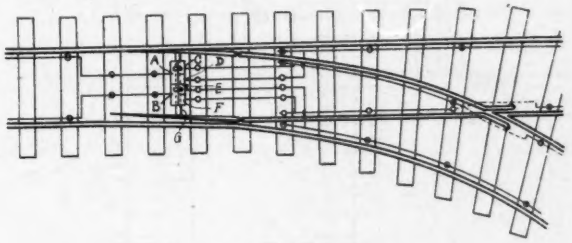


Fig. 1.

tion (as described in the specification), the mechanism is not brought into play, and no current normally flows. Immediately, however, that two trains approach or follow one another within the danger zone, the circuit of the current is completed between the two trains, resulting in both drivers being warned of their danger by means of electric bells placed in the cabs of the engines, whilst a train which attempted to enter a section already occupied by another train would be automatically brought to a standstill independently of an action on the part of its driver.

In the case of "opposing" (meeting) trains, the circuit of the current is completed at a distance of two sections from one another, while "following" trains are enabled to proceed at an interval of one section.

The inventor has recently improved his system to the extent of providing for closed circuits, by which means a visual indication is given in the cab of the engine by miniature semaphore or other signal, and the driver is thereby warned if his current has failed or the line is broken at any point. This indication also serves as a warning in the event of the line being broken through washouts. With the use of overhead wires in conjunction with the line wires, it is also proposed to establish a means of communication from trains to stations by telephones, so that in the event of a breakdown the driver can advise the nearest station of the cause of the breakdown, and obtain assistance without unnecessary waste of time.

The fact that a train is in occupation of the line between any two stations or sidings can also be automatically indicated at the station head by the transmission of current from the train to the overhead wires (carried on the ordinary telegraph poles), the current in turn operating discs placed in a conspicuous position at stations. With a system of this kind in working, it is also possible to dispense with a large number of the signals at present in use on railways, for, as has already been pointed out, the trains themselves carry their own indication as to whether or not the line is clear for them to proceed.

Specification.

A battery, accumulator, or dynamo of any required capacity is placed in a convenient position on each engine to admit of wires being led from it to a point adjoining the rails on the left hand side of the track. These wires terminate in a wire brush which is led down from beneath the engine on the left side, the brush being so adjusted that it wipes over a wire line carried on insulators in an approved manner to the sleepers, and running parallel to and between the rails. A wire line, similarly constructed, is also laid parallel to the right side of and within the track, and on to this a brush is let down from beneath the right hand side of the engine, but not connected with the source of the current. The latter brush is used for collecting current sent out by an opposing train except in such instances as the engine may be running tender foremost, when, by means of a permanent attachment to the reversing lever of the en-

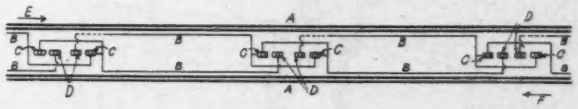


Fig. 2.

gine and connected with an electric switch the discharge of current is switched from the left to the right brush.

The design of the brush is as shown in drawing No. 1: (A) represents a metal bracket, bolted to, but insulated from, the engine on the left and right hand sides thereof; (B) a bracket to which one end of a spiral spring (C) is attached, the other end of the spring connecting with the bracket (D). The top end of a perpendicular rod (E) is let into a slot in bracket (B), and moves from side to side or up and down according to the pressure of the brush on the wire line. At the bottom end of this rod a pin (F) connects the brush (G) with the rod, thus enabling the brush to tip up when getting over obstacles. The brush is made of fine wire strands and the wires leading from the source of the current are led into it direct at (H).

For the purpose of adjusting the brush on the wire line as the former becomes worn, the bracket (B) is secured in a slot (I) and can be moved up or down as required. In order to ensure a continuous contact with the wire line, two or three similar brushes can, if desired, be fitted on each side of the engine. If desired, the metal brushes under both sides of the engine (connected with rods by means of the pins, as illustrated in drawing No. 1), can be replaced by small trolley, bogie, or suitable wheels of the like, connected together from side to side by means of suitable axles, bars or the like, insulated, in their centre. In the case of such replacement, the electric wiring, within the permanent way (as illustrated in drawing No. 2, hereafter more fully described), should also be replaced by small suitable rails or the like, so that the trolley will always be run, and will, by means of the contact or connection so made, continually convey the current from the source in the cab of the engine to such small rails, and from there along to the contact rails.

The method of wiring the line is illustrated in drawing No. 2. For the purpose of affording greater despatch in the working of trains, a section line between any two stations or sidings can be sub-divided into short sections of.

say, one mile each, and the wire line on each side the track terminated in an insulated contact rail placed in the centrre of the track; (A-A) represents the rails (B-B) the wire lines, and (C) the insulated contact rails. The current discharged from the left-hand side of a train is communicated through the wire line (B) and electrifies the contact rail (C) at the terminal point. Separate contact rails (C) are provided for up and down trains and at the back of each of the rails an additional contact rail (D) is placed. The wire lines (B), over which the brushes travel, are led at right angles to the respective track rails (AA), immediately before reaching the contact rails (C), and are connected underground to the latter. The discharge of current from a train is, therefore, cut off within the limits of the contact rails (C), thus enabling trains to pass between these two points without being affected by their own current. When a train has passed over the contact rails (C) the current is thrown back into the contact rail (D) by means of an underground wire connecting with the wire line (B), and the current then

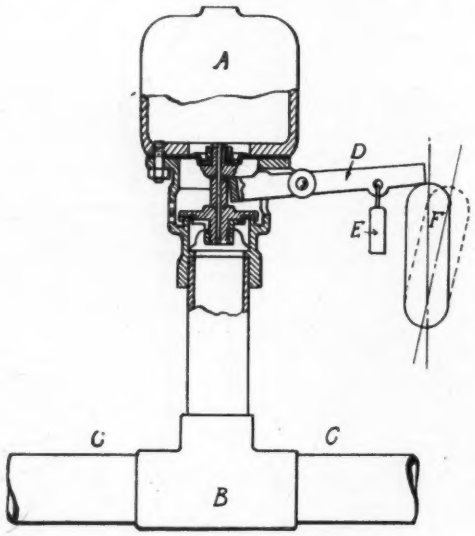


Fig. 3.

flows from that contact rail to the contact rail (C) at the terminal point of the next section. With the exception of the contact rails (C) situated within station limits, i. e., at or near the distant signals on either side of a station, all intermediate contact rails (C) are connected to the wire line (B) at a point where the latter crosses the track. This results in a free passage being available for the current sent out by an advancing trains, from contact rail (D) (down train) of the first section to contact rail (D) (up train) on the third section, the wire line being thus electrified within the limits of the two sections.

Drawing No. 3 illustrates the method of automatically stopping trains. A vacuum brake valve (A) is placed in the cab of each engine and connected by a junction pipe (B) with the main train pipe (C). From the lever (D) of the valve a weight (E) is suspended, and when in running position the lever is supported by a trigger (F). From beneath the centre of each engine a brush, similar to that illustrated in drawing No. 1, is similarly attached and let down to a point which will ensure its wiping over the contact rails (illustrated in drawing No. 2). This brush will be rather higher from the ground than the other brushes on either side of the engine, and is connected by wires to a magnet placed in close proximity to the trigger (F). When the current is picked up by the brush at the contact rail, the magnet is electrified and attracts the trigger to it. With the withdrawal of support from the lever (D) the suspended weight (E) causes the lever to drop, thus admitting air to the valve and thence throughout the train pipe. The admission of air to the valve can be so regulated that a sudden stoppage on the train is avoided.

A wire is also led from the magnet to the bell placed in the cab of the engine, and when the magnet is electrified, this bell is immediately rung and continues to ring until the current is withdrawn from the magnet. Contact rails are not placed at a lesser distance from a station than the distant signal on either side thereof, and in order to give due warning of the approach of trains to one another within those limits, an additional connection is made from the right-hand side brush of each engine to the bell in the cab. It, therefore, follows that when two trains are occupying the same section of line, warning bells are rung in each engine. An additional safeguard is then provided in the case of failure

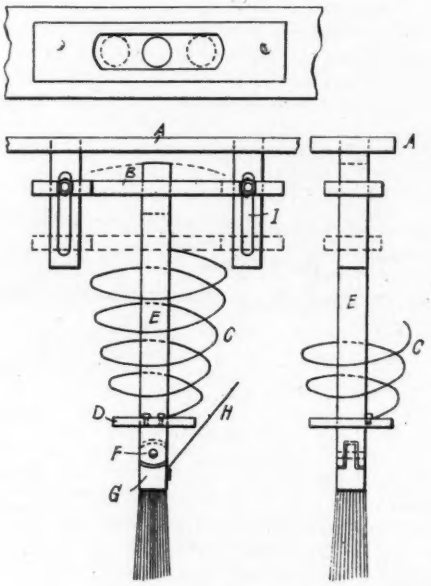


Fig. 4.

of trains to pick up the current at the rails. Communication between trains in occupation of the same section outside of station limits can be established by means of the bells on the engine in accordance with certain prescribed signals.

Drawing No. 4 illustrates the method of switching the current from one line to another at facing points. The main line wires terminate on a metal plate which is divided into two sections—(A) and (B)—and insulated from one another. A second metal plate, divided into four sections—(C), (D), (E), (F)—each insulated from one another, is placed parallel with the plate (A), (B), and between these two plates a cross-bar (G), to which two electric switches are attached, is connected with, and fixed to the movable rails of the points. The wires from the main and branch lines inside of the points are connected up with, and terminate in, the sections—(C), (D), (E), (F)—of the plate, and the switches on the crossbar automatically with the setting of the points connect up the wires of the one line with the wires of the line for which the points are set.

Audible signals of the approach of trains to level crossings or other danger points (such as sharp curves, bridges, or lines undergoing repairs) can be given by fixing bells at such level crossings or at points at a convenient distance from such other danger points, and connecting up with the main line wires, the current discharged from an approaching

train causing them to ring during the time it is in occupation of the section.

Visual signals can also be given by utilizing the current for lighting lamps at level crossings or other danger points.

AUTOMATIC BLOCK SIGNAL CIRCUITS.

B. W. Meisel.

The following article is a continuation of the fundamental principles of Automatic Signal Circuits which was started in the August issue.

Figure 1 illustrates a scheme of signaling sometimes used on steam roads where the traffic is light and simple protection only is required. Home and distant signals on separate masts are used, there being a distant for every home signal as shown in the figure. The home signals are numbered 1 and 2 and the distant signals are numbered D1 and D2.

The magnets or relays, which control the operating mechanisms of the signals, are shown at M1, M2, M3 and M4. The normal position of the semaphore blade is clear. The distant signals indicate the position of the home, and the home signals govern to the next home signal by means of a relayed track cut located at the distant signals.

Referring to the relayed track cut shown at D2, it will be noted that the track battery X2 which furnishes enregy for track relay B breaks through a point on relay C and whenever C is de-energized, which would be the case if a train were on the track section between D2 and 2, then relay B would also be de-energized and signal 1 would indicate "stop," and in turn D1 would indicate "caution." It will also be noted that the circuit for signal 2 breaks through a normally closed contact J5, in a circuit breaker operated by switch S. The contacts on this circuit breaker are either open or closed, depending upon the position of the switch S, and whenever the switch is reversed from the main line running, contact J5 is open and signal 2 indicates "stop." Also J3 and J4 are closed, introducing a shunt circuit across the track, which amounts to the same thing as a train in the block. In that case relay D is de-energized which opens the circuit for the control of signal 2.

If a train were on the section of track, as shown in the figure, between signals 1 and D2, relay B would be de-energized and signal 1 would indicate "stop," and remain at stop until the train passed signal 2. Signal D would indicate "caution" until the train passed signal 2 and signal 1 cleared.

After the train has passed signal 2, and track relay C again energized, the following circuits may be traced for the clearing of signal 1 and D1. Starting at positive pattery X2 the current flows through the positive rail to relay B, through relay B to the negative rail, back to a point P1, on relay C through P1, to negative battery X2. The current flowing through relay B causes the points P1 and P2 to close on B relay, and the circuit for clearing signal 1 may be traced as follows: Starting at position battery B, the current flows through M2 to P1, through P1 to negative battery. The current flowing through M2 clears signal 1 and contact J1 closes, which completes the circuit for clearing D1, which may be traced as follows: From positive battery B1 the current flows through J1 to P2 on relay B through P1 to line wire 1 to P1 on relay A, through P1 to M1 back on the line wire to negative battery B1. In a similar manner the circuit for the clearing of signals 2 and D2 may be traced.

(To be continued.)

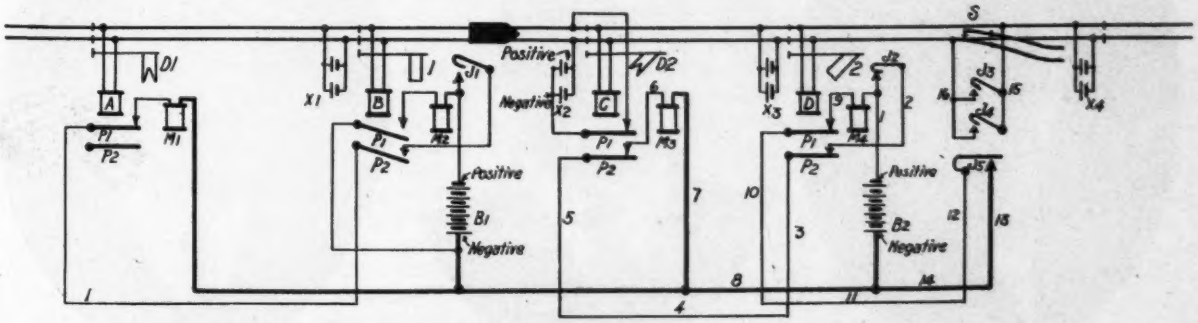


Diagram of Normal Clear Signal and Track Circuits with Home and Distant Signals on Different Masts.

In connection with the terminal improvements of the Grand Trunk at Bay City, the company is putting up an addition to the station, which will cost about $75,000.

The Manufacturers' Ry. of St. Louis has taken bids for an engine house and machine shop 80 x 390 ft., of concrete and steel construction.

The Roanoke Bridge Co., Roanoke, Va., has been awarded the contract for the construction of a steel bridge over Elk Creek, 10 miles from Fries on the Norfolk & Western in Grayson County, at $1,550. The structure will consist of an 87-ft. 6-in. span with 12-ft. roadway resting on concrete substructure.

It is rumored at Lisbon, N. Dak., that the officials of the Northern Pacific have under consideration the construction of a new high line bridge to span the bluffs at that place.

The Pennsylvania has plans made for putting up new rest houses at Sunnyside yard, Long Island City, at the Pennsylvania station in New York City, and at Waverly Transfer, N. J.

The Board of Aldermen, Raleigh, N. C., at a recent meeting reached an agreement with the Seaboard Air Line and the Southern whereby the companies will construct a bridge over Boylan Ave. at a cost of $15,000, and the Seaboard will build its share of a $27,000 bridge at Hillsboro St. crossing.

The Albany Terminal Co. has taken bids for the construction of its new union passenger station at Albany, Ga. It will expend $110,000 for the station and terminal improvements.

The Boston & Albany will build new bridges to carry its tracks over highways in Westboro, Rochdale, Palmer, Springfield, Pittsfield and Richmond, in the vicinity of Boston. They will be heavier than those which they replace.

The Chicago, Milwaukee & Puget Sound will begin work shortly on a new freight warehouse, 430 ft. x 175 ft., at Tacoma, Wash.

The Chicago, Rock Island & Pacific has awarded the contract for a 20-stall roundhouse at Manly Jct., Ia.

The Grade Crossing Commission of Buffalo, N. Y., has signed the agreement calling for the elimination of all grade crossings on the Erie's belt line of Niagara Falls branch at an expense of $1,000,000.

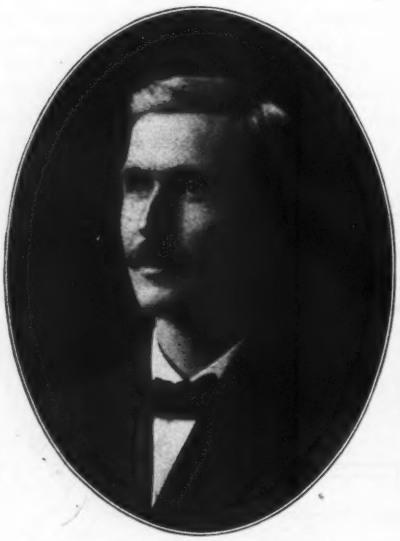
The Maintenance of Way Department

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.

Report of 30th Annual Convention.

The thirtieth annual convention of the Roadmasters and Maintenance of Way Association was held September 10-13 at Hotel Statler, Buffalo, N. Y. The meeting was called to order at 10:30 A. M. Mr. A. M. Clough, president, made the opening address.

B. M. McDonald, division engineer of the New York Central & Hudson, gave an address of welcome. In his talk he mentioned the difficulties met with in obtaining a competent roadmaster, and the training necessary to develop an efficient roadmaster. He dwelt upon the fact that there is a field, *i. e.*, the practical field, which comes within the province of the Roadmasters' Association and is outside of the scope of other associations.



Wm. Shea, Roadmaster C. M. & St. P., President.

T. F. Donohoe, Roadmaster B. & O., First Vice-President.

L. C. Ryan, Roadmaster C. & N. W., Secretary and Treasurer.

Newly Elected Officers of the Roadmaster's and Maintenance of Way Association.

PRESIDENT'S OPENING ADDRESS.

We are celebrating our thirtieth anniversary in the city of Buffalo this morning. Thirty years of the life of our Association have passed into history and we have thirty reasons for being glad we are here on this most auspicious occasion.

One of them, far outweighing all others in my estimation, is the fact that this most honorable Association when founded thirty years ago, had then, as we have now, honest, energetic, honorable men as its officers and members, and that in all those years, not a single untoward act nor a dishonorable deed has marred the fair pages of its history. It has had its dark days, it is true, but to-day it stands out strong and healthy and unique in the category of societies, in that for three decades its record is one of absolute devotion to duty, utter unselfishness and self-effacement on the part of the members, who have had but one object in view. That object is "the upbuilding of the American railroad," not in theory, but in solid, practical bettering of the ways and means to do the work, by improving material and tools, by improving the personnel of its working forces by meeting in convention each year and profiting by each other's experience, by promulgating our deliberations and conclusions in readable form to every railroad in America, Canada, and sometimes, to lands across the sea. Not a single word is to be found in its archives complaining that the roadmasters' remuneration was too little, or that the reward should be more for efforts which we know were often strained to the last point of endurance.

Its founders were that type of men who do not know defeat. And I want to pay loving tribute to the memory of those of them who have passed beyond this earthly sphere and tender grateful compliments to those that are still spared to enjoy the fruits of their labor in well-earned rest and retirement but who are no longer able to meet with us here, to those still in active life but in other branches of business, and last, but most sincerely, to those whom we still count among our own.

Not all of you may recall the beautiful lines that were inscribed over the "Peristile," the lake entrance to the gorgeous World's Columbian Exposition at Chicago in 1893; many of you may not know it was even there. These are the lines:

> "But bolder they, who first off cast
> Their mooring from the habitual past;
> And ventured chartless on the Sea
> Of storm-engendering liberty."

Thus, the designer, the builder, those cunning in every art and science that had reared this immense fabric laid down the gauntlet, bowed in homage to those venturesome souls who first braved the "storm-engendering sea of liberty." And so to-day, I want to lay on the altar of kind remembrance, our love, our reverence, our respect, and our homage, to those devoted men who first launched this, our beloved Association, practically chartless, out onto the "storm-engendering sea" of its existence and guided it with unerring hand on and up to where we, in twentieth century splendor and enlightenment, stand to-day. The names of Burnett, Craig, Sloan, Stearns, Moll, Jones, Lovell, Jordan, Adamson, Galerneau, Doyle, Swinney, Linsley, Kerwin, Hickey, Meade, Black, Caffery, Sweeney, Emery, and scores of others, the fathers of our Association, stood for all that was best in their profession and best for us who were decreed to follow in their footsteps. Theirs were the mud tracks, light chair rails, stub

switches, extemporized frogs, fenceless right of way, pit cattle guards, and countless other excuses of what we have in their perfection now.

The object of the Association was to meet and discuss questions pertaining to maintenance of way and to raise the standard of work committed to the charge of its members. It has carried out this object to the letter (with perhaps one exception) each recurring year showing a decided gain over its predecessor, both in larger and more important matters reported upon by committees, fuller and more comprehensive discussions, higher standards aimed at, and decidedly firmer stands taken upon the enlarging, strengthening and improving of all articles and material needed and used in constructing track and maintaining the same. We have investigated and recommend heavier rails, better joints, improved frogs and switches, better ballast, improved tools, tables of mileage of sections and number of men on same, standard lists of tools and their description, tie plugs, tie plates, and in more recent years, tie preservation, stone ballast, artificial ties, gasoline cars, and so forth, showing that the Association has been ever alive to the necessities confronting it, on account of heavier equipment and faster speed and every contingency of the day and age even before it was apparent to any but the trained eye or prophetic instinct of the men who were virtually living in and with their vocations. So that to-day we stand well up in the perfection of material and devices needed in our profession and do not have the same problems to grapple with that our predecessors had. Our present aim is to further perfect, making better and stronger by more improved methods, carrying along on a larger and more rapid scale, innumerable designs, customs, and usages devised two or three decades ago and largely by those men who this morning we are delighted to honor and who, I am sure, we most willingly concede were bolder and better men than we are.

Our future, who can say what it will be? Certainly, there will be no standing still nor will there be any retrogressing. Although I do not predict much change in the fundamental principle of our track construction, rails will yet be made heavier and ties constructed of different material. Frogs and switches, while the same in principle, will be made heavier and improved. Crushed rock ballast will be universally used, improved means of propulsion for care of our working forces will be generally used and detail articles will multiply and improve and fill wants long apparent. Evidence of this will be found in the magnificent display of the Track Supply Association on the parlor floor.

And trackmen of every grade, if they wish to keep abreast of the times, should appreciate the benefit to be derived in reading the literature pertaining to their calling which is so lavishly placed within their reach by the publishers of the splendid technical journals, who grace our Convention by their presence.

Members of our Association, old and new, should recognize the educational value of these reunions, impart it to their neighbors who are still outside the pale, attend every convention they possibly can and take part in the discussions; and during the year, write frequently to the president and the secretary, contributing to our Bulletin anything they think will interest or help their fellowmen.

The ladies I know will do their part and I predict, nay, I am sure, there will not be present a roadmaster's mother, wife or daughter, who will not be a member of the Ladies' Auxiliary to the Roadmasters and Maintenance of Way Association of America.

And let me say in conclusion, that it is with grateful hearts that the officers of this Association look upon this vast assembly. We hope you will enjoy yourselves to the fullest measure. To the Supply Men's Association, we say—Immense—not only their presence here and the exhibit they have prepared for us, but for a year of effort in behalf of this society and courtesies too numerous to mention. And we say the same to the representatives of the Technical Journals who are with us this morning. They have done splendid work for our Association and our thanks are most graciously returned.

COMMITTEE REPORTS.

Stone Ballast from the Crusher Into the Track.

The question of stone ballast is an extremely important one with the maintenance of way departments of the larger railroads of the country.

On the railroads where it can be procured, the ballast is either crushed by the railroad or purchased from private parties.

A thorough discussion of the kind of ballast, equipment for handling it, methods and amount necessary for making good track is considered timely, and your committee beg to submit the following paper:

Rock ballast should be made from hard, tough, durable trap, flint, or limestone rock, or other hard stone, acceptable to the chief engineer or engineer maintenance of way.

The stone should be broken to cubes, the maximum of which will pass through a two and one-half-inch ring and the minimum of which will not pass through a one and one-half-inch ring. The crushed stone should be free from screenings, dirt and rubbish.

Ballast can be handled in side dump cars with flat bottoms, or coal cars, but the Rodger ballast, Hart convertible, or any of similar type of ballast car on the market will give very good results. Ballast after being unloaded should be handled with a spreader, the Rodger ballast plow giving very good results.

The track should be prepared for ballast by digging out the old ballast down to the bottom of the ties at the end, rounding up to one-half inch above bottom of ties in center. This will keep ties from running together until track is filled with stone. Shoulder should be leveled off at end of ties.

All decayed ties should be removed and replaced with new ones. Ties should be properly spaced and track put to gauge and all spikes driven down so that ties will be tight up to rail. Then crushed stone ballast should be unloaded to fill up between the ties in center of track. This will help keep track in line and prevent ties from bunching.

Eight or twelve inches of stone ballast should be placed under ties if possible and a minimum depth of four inches should be maintained.

In giving track a nine-inch raise, it can be put up in one lift if a large force of men can be secured. Ordinarily the track is put up in two lifts. In raising in one lift the foreman in charge, by practice, will soon learn how many rails a train of fifteen or twenty fifty-ton cars will raise to the required height. The number of rails are counted off and sufficient ballast is unloaded and plowed out. Four men are started making places for jacks. One end of the sight board is placed on stake, and board leveled. Four jacks are used; two, one-half rail ahead of others, the first pair raising the track about one-half the required height.

No tamping is required with the head jacks, as the stone runs under the track by its own weight. The second pair of jacks raises the track to the required height. A force of twenty men should follow behind whose particular work is to tamp and these should be followed by a foreman and eight men to keep the track in perfect line. The first half of the day should be given to raising the track, the balance of the day being devoted to tamping and lining.

Where two lifts are made, the ties should be tamped with shovels their entire length. After the second lift, the ties should be tamped with tamping picks or bars, the tamping extending from ends of ties to twelve inches on inside of rail. Particular attention should be paid to tamping under the rail but the center of the ties should not be tamped.

In dressing up single track with ballast, the ballast should be filled in at least within one inch of top of ties and should slope

from ends of ties to edge of ballast shoulder. This shoulder should not be less than four feet from gauge line of outside rail to the edge of shoulder.

Double track should be dressed in the same way, stone in center ditch being level with stone in track. When the track is bonded for electric signals, it is very desirable that the stone be kept below base of rail. The track, after being raised, should be left from four to six days before dressing up.

In handling six hundred to one thousand yards of stone daily and giving track nine to twelve inches raise, although a force of forty to fifty men should be used, the force employed largely depends on the amount of traffic handled, and the views of the maintenance of way officials. A force of men organized as follows will give excellent results:

1 chief foreman.
1 assistant foreman to raise track.
1 assistant foreman to line track.
2 men flagging.
4 men digging out for jacks.
13 men on jacks (4 digging holes, 8 on jacks, 1 with levelboard).
20 men tamping.
8 men lining.
1 water boy (or more if necessary).

Fred B. Adams, chairman, P. & R. Ry.; John D. Boland, U. P. R. R.; A. M. Clough, N. Y. C. & H. R. R. R.; Henry Kleine, C. & A. Ry.; Wm. Brandt, C. & N. W. Ry.; Michael Deltgen, C. & N. W. Ry.

Minority Report.

In the main I agree with the report of the majority of the committee. I disagree with them, however, on the size of stone which they recommend for use, as I believe it to be too large for the maintenanee of good track. My idea is that the size should run from one and three-quarter inches to one-half or three-quarters inches.

I do not believe that we should make stone crushers of our men which certainly must be done if large stone is used in jointing up track in after years.

D. Foley, M. C. R. R.

Discussion.

A motion was passed that the report be read, discussed, and passed upon by paragraphs.

A. M. Clough, N. Y. C. & H. R.—This report does not consider the advantages of different kinds of ballast, but discusses specifications for rock ballast, and methods of handling it.

T. Hickey, Mich. Cent.—Stone ballast should be made of the hardest stone possible to procure.

A. McNabb, Mich. Cent.—I would not advocate using limestone, as it is too soft, and if fine, the track will churn.

J. R. Coulston, L. E. & W.—The paragraph, it seems to me, is all right and broad enough to fit all conditions.

A. A. Wells, Southern.—I think limestone should be eliminated as it is too soft.

A. M. Clough, N. Y. C. & H. R.—I have found that limestone will crumble, and think it is not durable enough for ballast. I have found soft limestone in gravel ballast will cause trouble.

M. Burke, C., M. & St. P.—If we refuse to use limestone for ballast, many miles of track will never have stone ballast because other stone cannot be obtained.

M. A. McNeil, A., T. & S. F.—We must take that stone which is available and make the best of it. After making many tests, we have used limestone in a lot of our track and found it satisfactory. In some localities it is limestone or no stone.

W. M. Camp—The hardness should be the governing feature if limestone is to be used. Limestone varies from an extremely hard stone to chalk.

P. M. Dinan, Lehigh Valley.—We are using a flint limestone and find it makes a very good ballast.

J. P. Corcoran, C. & A.—We have used limestone as well as crushed boulders and find them both good.

A motion was carried to accept the paragraph as read.

J. Johnson, N. Y. C. & H. R.—I think the size of stone specified is too large. I think the sizes of stone should be maximum 2 in., minimum ½ in. Coarse trap rock ballast will gradually slip and settle down, and wont hold up track as well as limestone.

T. Hickey, Mich. Cent.—I think the 2½-in. stone too large and would suggest a maximum size of 2 inches.

M. A. McNeil, A., T. & S. F.—I think the size of stone should depend somewhat on the climate. Small stone, say from 2 to 2½-inch, make good ballast in a dry country.

G. Lowers, Erie.—With a ½-in. raise and large stone, if you raise the joint only it will nearly always be tamped up too stiff. Then when the center is raised, it will be tamped up too stiff.

A. M. Clough, N. Y. C. & H. R.—Large stone ballast prevents or eliminates pumping track. In tamping with stone ballast, the object should not be to force certain small stones under the tie, as the bearing, in that case, would be only on a few points. The stones under the tie should be displaced and forced upward when tamping to form a uniform bearing across the entire bottom of the tie.

D. J. O'Hern, E. J. & E.—When tamping only 12 ins. back of rail, coarse stone will in time cause center bound track, while fine stone will not. A mixture of large and small stones makes a cement which weeds cannot grow through.

A. McNabb, Mich. Cent.—I agree that stone should run from 2 inches to ½ inch. The labor is to be considered and small stones make quicker work.

M. Donahoe, Chicago & Alton.—The difference of opinion on this subject is largely due to different standards of maintenance. The highest class railways use the larger stone. New ballast costs on an average $1.00 per yard. Coarse ballast can be cleaned when it becomes dirty and used again at a cost of 25 cents per yard, and is practically as good as new. Small stones must be thrown away when ballast gets dirty.

L. C. Ryan, C. & N. W.—I am very much opposed to having the minimum size of stone 1½ inches. In ballasting 75 miles of track we had two kinds of ballast. Coarser ballast consisted of stone from 2½ to 1½ inches. The finer ballast was of 2 to ½-inch stone. The ballast was used under exactly similar conditions with a 10-inch raise. The track on the coarse stone will not stay up. The track on the finest ballast stays up. The small stones fill up the voids and prevent settling which occurs in coarse ballast.

The paragraph was accepted with an amendment eliminating the word "cubes" and substituting "pieces," and also changing the size of stones from maximum to pass through 2-inch ring, and minimum not to pass through ½-inch ring.

Paragraphs 3, 4 and 5 were accepted as read without discussion. Paragraph 6 was read.

A. B. Richards, L. E. & W.—I move that the minimum depth of stone ballast to be maintained be changed from 4 to 6 inches.

M. Burke, C., M. & St. P.—Six inches of stone beneath the tie is sufficient if sub-ballast is a well drained bed of good gravel or cinders.

T. Hickey, Mich. Cent.—The minimum lift for stone should be 8 inches. A 9-inch raise should never be dressed up same day raised, but left for a week and sniped up.

Foreign Labor.

Your committee realizes that it is a grim fact that track labor has very materially deteriorated, both in intelligence and efficiency. The cost of maintenance has gone up while efficiency has come down. Men of a class such as followed track work years ago are no longer to be found on sections or in extra gangs. They have taken up other lines of work where the op-

portunity for advancement is better and the compensation higher. Less robust and less intelligent foreigners have taken their places and at the present time the element that composes the majority of our labor forces on American railways is made up of the races from Southern Europe of whom the Italians are probably in the majority. This is particularly true of the East and middle West. In addition we have the Japanese laborer on the Pacific slope while the negro and native white compose the labor forces of the South.

It is plainly evident that we must depend almost entirely upon the foreigner for our source of labor supply for the present as well as the future. The question which then confronts us is: "How are we to obtain efficiency from this foreign class of labor in the shortest space of time?"

The first point to be considered is the method of obtaining the service of these men. Where it is possible to do so we would recommend that the necessary labor force be obtained locally by the roadmaster or foreman. If the required number cannot be secured in this manner, we would then suggest that the railway maintain a labor bureau of its own at some central point where laborers usually assemble to seek employment. Let it be the policy of these railway labor bureaus to furnish free employment, free transportation and, when necessary, send a company representative with the men to their destination and turn them over to the foreman for whom they were engaged without any first cost to them, either legitimate or extortionate. By this means the man so employed will readily realize that he is placed upon his own resources and that upon his own individual energy will very materially depend how long he will be retained in the service.

Another method for obtaining laborers is through the regular employment agencies. This method is not always satisfactory due to the fact that through eagerness to secure a shipment of laborers and earn the fee connected therewith the labor agent too often makes promises of future increase of wages and promises concessions of various kinds that local railway officials cannot fulfill. The result of these ill-advised promises is trouble and discontent among the men and worry and trouble for the roadmaster and his assistants. As a means of partly preventing this abuse, an impartial representative of the railway company should be appointed to scrutinize all contracts made with men and satisfy himself that nothing is promised either for the present or the future except what can actually be fulfilled. The necessary information regarding the kind of work, probable length of time of employment, etc., can always be obtained from the local or general offices of the company and this information should be given to the men. We are not in favor of hiring laborers through the regular employment agencies except where it is impossible to secure them by the other two methods mentioned.

We are very much opposed to the method of obtaining laborers through such men as interpreters, bookmen, commissary men, etc., on promises of appointment as interpreters, sub-foremen and time keepers for the gangs, or allowing boarding house privileges for the purpose of furnishing meals and lodging to the laborers furnished. The kind of men who obtain such privilege are usually foreigners who have worked in a section or extra gang for a few years until they have acquired a fair knowledge of English, an indifferent idea of practical railroad work and an unlimited nerve. One of these gathers together a gang of "green" men who have little or no knowledge either of English or track work and who become quite dependent on him to keep them in employment. He represents himself to them as one thoroughly skilled in the work required and he undertakes to instruct them in the work.

The concession usually demanded by this type of labor agent is that he be appointed interpreter, sub-foreman, timekeeper, or commissary man for furnishing a certain number of men. As an interpreter, sub-foreman or timekeeper his authority over the gang is such that it is difficult to cull out the poor material and replace with a better class of men without losing the entire gang, as the leader is unfortunately too short-sighted to realize that with a better grade of labor he has a vastly better chance to secure steady employment. Usually the interpreter extorts a certain amount of money from each "green" foreigner for whom he secures work on his assurances of steady employment. He thus practically binds himself to keep these men at work regardless of their fitness or unfitness. The sole interest that the commissary man has in the labor he supplies is to extract every penny possible by charging exorbitant rates for provisions which the laborers are compelled to purchase from him and an extortionate rent for small and unsanitary sleeping quarters.

The results from such a system is a perpetual "green" gang. The men are fleeced to such an extent that as soon as they earn a few dollars which they can call their own they quit their unprofitable jobs, and inexperienced new hands are furnished in their places.

There is no hope of ever getting any satisfactory results under this system for any of the parties interested except the commissary men.

The next point to be considered is the best method of housing the men so that, by improving their living conditions, we may the more easily obtain and retain their services. Owing to the fact that conditions vary on different railroads and in different localities, the details of furnishing quarters for the men must be largely a matter governed by such conditions. For the average section gangs, shanties of suitable size with good light and ventilation should be provided, with sleeping rooms separate from the living room, particularly if the men do their own cooking. Where better accommodations cannot be furnished, old box car bodies remodelled with necessary windows, doors, partitions, well ceiled and with good floors, make good, cheap shanties. All shanties should be furnished with necessary lamps and a heating or cooking stove as the occasion demands.

The proper housing of the men is a most important matter as an aid in keeping the men satisfied and in increasing their efficiency. Where men are properly housed they are always willing to return to the same company year after year. Good treatment of the men in this respect usually results in their continuing in track work when they might otherwise engage in other occupations.

The sanitary conditions are most important. Necessary toilets must be maintained. The foreman in charge should closely watch these things and insist that the buildings occupied and used by his men are at all times kept neat and clean and that the grounds surrounding the buildings are also kept tidy. A great deal of the local prejudice against foreign labor is due to the filthy habits that on the surface seem to be general among the men. We cannot exercise too much supervision over this particular feature.

Extra gangs should be fitted out with good cars with stoves, light and ventilation. There should be plenty of room for sleeping quarters or bunks. Some companies provide portable shanties which are placed on flat cars in Summer and moved from station to station as desired. In the Fall at the close of the extra gang season, the shanties are removed from the cars and the flats turned back into logging or lumber service. All railroads cannot do this but they can and should provide living quarters for their laborers somewhat suitable to the needs of human beings. The sanitation of these outfits should not be overlooked and every one should be alert to avoid complaint in this important matter. A watchman or carekeeper should be employed to keep the extra gang cars neat, clean, comfortable and warm for the men when they come in from work at night. Such a man could also find time to look after the care of all tools not in daily use.

How to obtain the confidence and increase the efficiency of the foreign laborers in the shortest space of time is a problem. Much depends on the foreman. Those of us who have gone through the mill of actual experience realize that it is not an easy task to make good track men out of Italians, Japs, Greeks and Mexicans and it is still more difficult to teach them to speak and write the English language. Make them obedient to American laws and perhaps later on they may develop into competent foremen. This is practically what a foreman must do, at least in a rudimentary way.

The first thing, therefore, is to obtain the confidence of the men. All gangs of men cannot be handled by rule but observation of their habits and inclinations will show how they should be approached to obtain the best results. Avoid abuse. Explain as clearly as possible just what is to be done. Make no promises that cannot be fulfilled. Allow full time for every moment worked. Give liberal allowances of time and proper food when working overtime in emergencies, in stormy weather. Keep them always under submission by granting no concessions if a threat to quit accompanies the request. Instruct the men to become law-abiding citizens, and do not permit them to carry or possess any kind of dangerous weapons. Accustom them to the idea of keeping their home surroundings neat and sanitary. Explain how best to make purchases of clothing and provisions so that they won't be fleeced by men of their own nationality who may have been somewhat shrewder than they and have started small stores for this purpose. Aid them to learn the English language by explaining the names of the various track tools and equipment they come in contact with every day. By such means as this foremen can gain the confidence of their men and make them good and efficient track men in a short time. All of this can be accomplished if the foreman is given proper aid by the roadmaster and the railway company, particularly the latter. Except in emergencies, a uniform Summer and Winter force can be arranged, particularly for sections.

There is no feature of track maintenance of such importance as the organization. Railway companies each year should readily anticipate their wants and proposed expenditures as regards the section forces. The labor sheet should accordingly be gotten up promptly and thoroughly for both Winter and Summer service. For the Summer work an average force of men should be employed early in the Spring and such gang kept on each section until the Fall except in the case of those railways where it is desired to get the track in shape for the many additional trains by which to take care of heavy suburban Summer traffic.

It is plain that if you employ three Italians on a certain section in April it may be difficult to engage three more in May or some succeeding month. There would have been much less trouble in securing the six in April. The system should be reversed. If six men had been hired in April, the number could have been reduced to three in May, due to a probable stagnation in traffic, and increased again to six or eight in some succeeding month. Even if the men could readily be obtained, there is no economy as it simply means a renewal of a "green" force, and there is certainly no encouragement to the foreman in his endeavor to obtain efficiency when a system of this kind is carried on. We especially denounce as false economy the practice of railway managements in endeavoring to save a dollar in May and then spend ten in October with a "green" gang in an endeavor to catch up with the work that was neglected earlier in the season.

On the question of interpreters we do not approve of them simply as interpreters and without any knowledge of track work. Ordinarily on sections there are to be found several men in each gang who understand sufficient English to explain to the others just what the foreman wants. Where large gangs are employed and a man of the same nationality as the others is found capable of acting as a sub-foreman, he should be employed as such at a suitable increase in salary. The man so appointed should be given to understand that his retention in that capacity and his possible advancement to the position of foreman later on, depends upon his success in getting the best results out of the men. As we must depend very largely on the class of labor which we now employ for foremen of the future, we deem it a wise plan that, where any member of a gang shows ability and takes an interest in the work, he should be given some supervising part such as lining or surfacing track, and to provide an opportunity for the development of such a man into a foreman, a small floating gang should be placed in his charge to assist various sections as required.

This method gives the student an opportunity of working under different foremen and we believe that it is a very good method for educating foreign laborers for the position of track foreman. The salary of such a man need be only a little above that of the ordinary laborer but he should be employed the entire year. Some railways allow sub-foremen on some of the most important sections as a means of educating them for the position of foremen at a minor increase in wages above that of the laborers, always selecting the most experienced man and the one who shows the strongest disposition and desire to learn. This also has proven to be a very successful plan. We find that such foreigners make very good foremen and in many instances get better results out of the men of their own nationality than do American foremen. This of course is in a great measure due to the fact that they can talk to and explain the work to their men. In addition they take part in the work with their men much more than do American foremen who are loath to work alongside a gang of foreign laborers. One of the greatest drawbacks, however, in making foremen out of foreign laborers is their inability to read or write the English language.

There is no question but that there is local prejudice against foreign laborers. This can be overcome to a great extent by educating the men to endeavor to live as the average American does. Neatness and cleanliness about their persons and their home surroundings should be thoroughly impressed upon them. The carrying of dangerous weapons should be frowned upon. Quarreling should not be tolerated. They should be taught by example to be honest and truthful in all their dealings and to observe closely and to pattern after the general run of good American citizens. Give them to understand that this is a free country and that as long as they conform strictly to its laws as other men do and as long as they do not become a nuisance to the community in which they live, it is not necessary for them to pay a cent for the privilege of earning an honest living. In a nation made up of foreigners it would come with ill grace to now object to the employment of such in track work, and while we are ready to admit that a few are undesirable as citizens, we can easily point out where thousands have become good members of society and with proper training and education are well worthy to become citizens of our country.

Coleman King, chairman, L. I. R. R.; P. J. McAndrews, C. & N. W. Ry.; G. M. Greene, C., R. I. & P. Ry.; J. W. Fletcher, Jr., Car. & N. W. Ry.; C. C. Johnston, L. & N. W. R. R.; A. B. Richards, L. E. & W. R. R.; B. A. West, A., T. & S. F. Ry.

Discussion.

This report was read and discussed by paragraphs.

M. Burke, C., M. & St. P.—In Chicago contractors pay from 35 to 45 cents per hour for laborers, and the laborers can draw their money at any time. The railways therefore get only the worst of the foreign labor.

J. P. Corcoran, C. & A.—We find if we start our spring work early, that we can hold our gangs all summer. Some railways dodge the issue of rate per hour, by allowing 11 or 12 hours for 10 hours' work, and still say they are paying only a certain rate per hour. This practice should be discouraged. Competing lines cannot hold their laborers under these conditions, and the men in charge are blamed because they cannot hold men, with the same rate of pay the other line claims it is paying.

A. M. Clough, N. Y. C. & H. R.—We should go on record as denouncing the giving of extra hours' pay for time not worked.

M. Burke, C., M. & St. P.—Railways which pay higher wages get better labor, and it resolves itself into a question of wages.

M. A. O'Neil, A., T. & S. F.—It seems to me it is a question of supply and demand, and there are not enough laborers in the Western country. Contractors pay twice as much as railways, and we cannot keep laborers though we house them well, treat them considerately, and see that they are not overcharged for commissary.

J. Johnson, N. Y. C. & H. R.—We employed Italians in 1886 and had no trouble with them as long as they were allowed to buy their provisions wherever they wished. When labor agents and commissary cars were introduced, we began to have trouble. Charging the men rent caused trouble. A labor agent should have no jurisdiction after the men get on the job.

L. C. Ryan, C. & N. W.—By paying more money I believe we get much more work out of the same men. By raising wages just a little we can get laborers away from contractors on account of the accommodations which men get free, from the railways.

Coleman King, L. I. R. R.—If we keep a full force the year around, we can compete with contractors, even if they pay much higher wages.

M. Donahoe, C. & Q.—I move that Mr. King's report be accepted as information, and that we recommend higher wages be paid track laborers.

Motion carried.

How to Secure Foremen—Organization of Section—Length of Section.

We, your committee on "How to Secure Foremen—Organization of Section—Length of Section," beg to submit the following report, the subject having been thoroughly considered by all the members of the committee and the reports from the individual members being almost unanimous on the different questions at issue:

How to Secure Foremen:—It is agreed that, to secure competent foremen, good wages must be paid and to secure student foremen a salary should be paid sufficiently in excess of that paid section laborers to make it an inducement to young men with fair education, ambition and ability, to stay in the track department rather than work on farms or other places where wages may be higher but steady employment uncertain and the chance for promotion obscure.

Student foremen should be placed with the most progressive section or yard foremen so that they may learn all the latest methods and be taught in the most up-to-date manner how to acquit themselves when promotion comes to them, and they are thrown on their own resources. It goes without saying that section or yard foremen, so designated as teachers of prospective foremen, will endeavor, out of personal pride and with characteristic loyalty to their company, to turn out men who will be a credit to their instructors. These men should be paid twenty-five cents more per day than a regular track laborer for a day of ten hours and they, as well as all foremen, should be paid for over-time the same as other employes.

If after working one or two years on a straight section, student foremen are moved into a terminal or yard, they will get experience in switch work, heavy track repairs, and work of this character and an insight into many phases of track work not encountered on sections, thus making them much more resourceful when the time comes for them to assume control of their own sections. With proper training, as outlined, and with the prospect of attractive wages as a section, yard or extra gang foreman, when the time for promotion comes, the problem of securing competent foremen will to a great extent be solved.

There should be four student foremen on every division of twenty-five sections and additional ones where the number of sections exceeds this. A yard foreman should receive more wages than a section foreman and it should be considered a promotion for the latter to be placed in charge of a yard. The pay of an extra gang foreman should be larger than that of a yard foreman and men selected to handle extra gangs should be next in line for the position of assistant roadmaster. This system should be the settled policy of every railroad. All promotions from that of student foreman and extra gang foremen to roadmaster should be held before the wide-awake, ambitious man as an inducement for him to work in the maintenance of way department.

A merit system is also recommended whereby due credit can be given to foremen in every capacity for alacrity, resourcefulness and initiative in cases of emergency. The position of foreman in the track department would then be desirable.

Length of Sections:—Where the equivalent mileage basis of designating length of sections is not used, a section of four tracks should be two miles long; three tracks, two and one half miles; two track, three miles; and one track, five miles. Equivalent mileage is usually figured on the principal railroads at the rate of one mile of main track to a mile; two miles of main passing siding to a mile; three miles of spur, or commercial track to a mile; and fifteen switches to a mile. In yards, equivalent mileage will regulate the territory which a foreman with a given number of men should have under his jurisdiction.

Organization of Section:—Each section should consist of a foreman and one man to each mile of track in Summer, and one man to two miles of track in Winter when conditions are normal. In severe weather, however, when ice forms and snow storms prevail, a foreman should be allowed to use his judgment in having extra men to keep switches clean and tracks open and to assist wherever necessary in order to keep traffic moving. Each section foreman should have an assistant for every ten men, the assistant to work the men and prevent them from getting in the way of trains.

The word "section" embraces all main line tracks and main line switches, sidings, freight house tracks, etc., at all way stations and through large yards; yard sections to include all tracks of every description outside of main line switches.

P. M. Dinan, Chairman, L. V. R. R.; L. A. Lewis, P. & R. Ry.; J. A. Roland, C. & N. W. Ry.; John Barth, C. C. C. & St. L. Ry.; Carl Buhrer, L. S. & M. S. Ry.; J. P. Corcoran, C. & A. Ry.; T. F. Donahoe, B. & O. R. R.; J. E. Wilkinson, C. & N. W. Ry.; Bruce James, C. & E. I. R. R.

Discussion.

The report was read and acted upon by paragraphs. Paragraphs 1 and 2 were accepted without discussion.

O'Hern, E. J. E.—I move that a sentence be added stating that two railroad crossings are equivalent to a mile of track. Motion Passed.

J. B. Oatman, B. R. & P.—I think one section laborer per mile of track is not enough and would like to see the report read 1 laborer per mile in winter and 1½ laborers per mile in summer.

M. Burke, C. M. & St. P.—If a track is kept up to standard 1 man per mile is sufficient. More men are necessary, however, if the track has run down.

T. Hickey, Mich. Cent.—I don't think one man per mile sufficient in stone ballast, but think there should be 1½. In gravel or cinder ballast 1 man per mile is sufficient.

L. C. Ryan, C. & N. W. Ry.—I offer an amendment as follows: "Each section should consist of one section foreman, and at no time less than 1 man per line of main line. More men shall be supplied, if necessary, to keep the track in the required condition.

J. Buell, Ark. Cent.—In the south we cannot expect 1 man per mile. We keep up 13 miles of track with 7 men and motor cars.

Paragraph 2, on equivalent mileage, was reopened at this point.

A. F. White, N. Y. P. & N.—I find that 4 fully planked street crossings require as much time as a mile of track, and move that a sentence be added to the clause stating that "4 fully planked street crossings are equivalent to a mile of track."

M. Donahue, C. & A.—I think that class "B" track, i. e. double track, should be assumed as an average for assigning number of men to the section and that class A should be allowed 25 per cent more laborers, and class C 25 per cent less.

The rest of the committee report was accepted with little discussion.

New and Improved Track Appliances.

Our present concern is the study of better foundations as represented by ballast and drainage, the consideration of the manufacture, shape and size of steel rail and the question of joints, plates and other appurtenances which will insure first of all greater safety and secondly economical track, and by this we mean that economy which is measured by maintenance standards.

1st, THE SHOULDER TIE PLATE. The Committee recommends extensive use of the shoulder tie plates, size 7½x9 in. covering surface from base of rail to outer edge on outside 2¼ in., on inside 1¾ in. from base of rail; 1½ in. thick at outside base of rail, tapering to 7-16 in. at inside base, giving the plate a little bevel so that the rail will sit up better and in a measure prevent the rolling out of the rail. They should have sufficient corrugations or flanges on the bottom to overcome rattling. The Committee recommends that tie plates be applied to all tracks on Main Line where heavy traffic warrants it, including all switch leads and turnouts.

2nd, RAIL ANCHORS. This appliance has gradually developed sufficiently both in weight and design to be satisfactory and while there are innumerable designs on the market we recommend those of fewest parts, which can be readily removed when rail is changed and can again be applied without loss or breakage.

3rd, SOLID MANGANESE FROGS. Boltless frogs, although a very new appliance and perhaps comparatively unknown to many roadmasters are commendable, for the reason that in themselves their weight and solid stability under heavy traffic entirely remove the wear and tear caused by the springing elastic motion of an ordinary frog. With a properly constructed toe and heel projection made for a standard splice bar projecting forward so that one-half its length engages the solid part of the frog, the solid manganese frog or the frog made of similar material is recommended.

4th, MANGANESE STEEL POINTS. We, recommened extensive use of solid manganese steel switchpoints, full length where the traffic is sufficient to warrant the expense of applying such points.

5th, A SOLID SWITCH SLIDE PLATE. Gauge plates should be 3¼ in. x 6 ft., insulated where necessary, turned up at both ends to form a shoulder for braces. The slide plate should be made of the same size, this to be 12 in. long and turned up similar on out ends for braces on every tie from the gauge plate to the heel of switch point. Also special plates should be provided for a sufficient distance back of heel of switch point until regular standard tie plate can be used.

6th, AUTOMATIC SWITCH STAND. For yard work we recommend automatic switch stands, in order to eliminate derailments and expense due to running through switches equipped with rigid stands.

7th, MOTOR HAND CARS FOR SECTION MEN. A gasoline motor hand car of simple two cycle design weighing from 650 lbs. to 700 lbs. is recommended. It should be so constructed that it can be propelled the same as any regular handcar in case of the engine breaking down.

8th, SCREW SPIKES. We recommend a more general adoption of the screw spike used on the Illinois Central, Santa Fe and B. & O. Railroad with special tie plates made to go with same. No rail anchors are needed with the screw spike this having been well proven on Western roads.

9th, HYDRO-CARBON FOR SNOW MELTING. Hydro-Carbon is a highly inflammable liquid which is used to melt snow at switches and comes in a drum of one hundred and fifty gallons capacity; three of these drums are said to be sufficient to keep six double slips with detector bars, or thirty-six single switches with detector bars, or seventy-two hand switches free from ice and snow for fifteen hours. The liquid is drawn into a safety distributing can and poured around, under and about the switches, detector bars, etc., and ignited. It is somewhat dangerous and has only been used experimentally.

10th, BALLAST SPRINKLER. Great discomfort and inconvenience has been experienced by passengers on fast trains, where stone ballasting operations are in progress from dust in the stone, particularly in continued dry weather when meals were being served in dining cars. This objectionable feature has been overcome by mounting two tanks on the ballast spreader car and sprinkling the stone with water. The tanks are placed on each end of the car and are provided with a sprinkler arrangement similar to a street sprinkler. A pipe connection between the two tanks permits the water to lower in both tanks at the same time and only one tank need be placed at water column when filling them up. The water is started as soon as the plow commences to plow the stone out. This entirely eliminates the dust in the trains and washes and cleans the stone.

11th, SOD LINE TRIMMER AND ROLLER. Where a sod line is maintained on the edge of standard roadbed it is usually straightened up once a year at considerable expense with a ditching line and shovels. A simple device has been found much more economical. It is attached to any hand car by simply placing a hanger for the arm on one end of the car with one bolt and placing the bridle for the brace over the handle at the other hand. Both the brace and arm are adjustable and it can be unshipped in five seconds by simply pulling the pin out of the back hanger and throwing the bridle off in front. There is a steel cutting disc on the inner end of the roller and a small plow inside of this disc. It rolls the sod and cuts and plows the rough edge of the sod, making it easy to rake off and trim from fifteen to twenty miles of track in one day with an ordinary section gang.

12th, A RAILROAD DITCHER. A railroad ditcher has recently been placed on the market that deserves more than passing notice. It can be used for sloping and ditching wet cuts, removing slides, handling rock, timber or ties and can also be used as a light wrecking crane with a range or portability not embodied in machines of steam shovel construction. It can be handled on the deck of an ordinary flat car on a portable track or can be placed on the ground and used in the same manner as a steam shovel. It swings in a complete circle and the boom can be lowered to pass any overhead obstruction. It is balanced so that it works without jacks or outriggers.

13th, RAIL BRACES. We recommend the use of malleable iron rail braces.

14th, GUARD RAIL CLAMPS. We are against the use of bolts alone for attaching the guard rail to the main rail and would strongly urge the use of guard rail clamps of which there are several good designs in use.

In improved appliances, we have recently had good reports

of the Hatfield railjoint, and of the Roach insulated joints. Also of a switch target in two pieces which dovetail into each other and slip over the stand spindle.

W. E. Emery, P. & P. U. Ry.; W. R. Thompson, Cent. of Ga.; J. F. McGuigan, St. L. & S. F.; A. G. Hart, Sou. Pac. R. R.

Discussion.

There was little discussion on this report, and it was accepted as information.

Methods for Obtaining the Best and Most Economical Results in Handling Construction Work.

The committee limited itself to the consideration of the question as whether the building of new yards and main lines not contracted should be handled exclusively by the engineering department, by the maintenance of way department, or directly under the supervision of a practical track man.

Considering the handling of work by the engineering department, the committee holds that the plans, specifications, etc., should be prepared by the chief engineer, but that the work should be in entire charge of a practical track man, but that there should be a resident engineer on the ground to lay out the work as ordered, in accordance with these specifications. Ample assistance should be provided the man in charge of the work. The wages paid to laborers on construction work of this character should be at least equal to that paid on other construction work in the immediate vicinity, irrespective of whether that work is of a private, municipal or railway character.

The man in charge can best ascertain the proper kind of material to be selected and the manner in which it should be placed in the sub-grade in order to eliminate the possibility of soft spots which so frequently develop in tracks under the pressure of heavy traffic and which form the most serious drawback to maintaining a track in first class shape. He can also provide good drainage, sufficient ballast under the ties, and proper spacing and placing of ties in accordance with the size and condition of ties provided, all of which are essential. Construction of all new track work or such tracks as come under the head of construction work should be completed in detail before being turned over to the maintenance department.

The committee recommends that the construction work should not be handled by the maintenance of way department, as the average roadmaster has as much maintenance work as he can properly attend to during the working season.

M. Burke (C. M. & St. P.); James Sweeney (C. & E. I.); Thomas Thompson (A. T. & S. F.); A. E. Muschott (C. R. I. & P.); M. Donahoe (C. & A.); George Barnoski (C. M. & St. P.); T. Hickey (M. C.).

Minority Report.

While in thorough accord with all that has been said above I desire to submit further that:

A saving in cost and time in construction work can be obtained by the use of a track laying machine in laying the first track, depending largely, of course, on good organization.

That second and other additional tracks can best be constructed by unloading the necessary material from the existing track, this to apply as well to yard tracks. All necessary grading can be done by train to very good advantage when the material is not at hand to be hauled by teams.

That the advantage in making train fills lies in the fact that better material can be obtained and used after the material is unloaded from the train with a side plow and leveled back to the full depth and width for an additional track. If gravel ballast is to be used it can also be unloaded and spread on the grade with a spreader to the width and height required before track laying so that when the steel is laid there is no lifting to be done beyond surfacing or a light lift.

M. Burke, Chairman.

Entertainment and Inspection Trips.

Dr. P. H. Dudley, consulting engineer, New York Central Lines, presented a paper on The Development in the Past Three Decades of Rail Sections, Higher Standards of Track, Heavier Equipment, Wheel and Train Loads and Faster Schedules, at the session Wednesday morning.

Wednesday afternoon, September 11, on invitation of the Lackawanna Steel Co., the convention adjourned to inspect the plant of that company. The trip was made under the guidance of Dr. P. H. Dudley, consulting engineer of the New York Central Lines, who explained the different steps in the manufacture of rail. A number of tests were made of the ductility and soundness of rails.

Thursday afternoon Hubbard & Co. entertained a number of members and the ladies on the steamer United Shores, and an international motor boat race was witnessed in which Mr. Hubbard had his motor boat Gretchen III entered.

In the evening following the adjournment of the Convention a banquet was tendered the members of the Roadmasters and Maintenance of Way Association by the Track Supply Association. The banquet was a great success from every point of view. The following toasts were given: Conservation, C. H. Stein, engineer maintenance of way, Central of New Jersey; Development of Rails and Track Structure, J. V. Neubert, engineer of track, N. Y. C. & H. R.; Maintenance of Large Terminals, H. J. Pfeiffer, engineer maintenance of way, Terminal R. R., of St. Louis; Manufacture of Steel Rails, Mr. Abbott inspecting engineer, Lackawanna Steel Co.

Friday, the members of the Roadmaster's Association were again the guests of the Track Supply Association, on a trip to Niagara Falls. The party left Buffalo, at about 10:00 a. m. on the N. Y. C. & H. R. R. R. leaving the train at Niagara Falls. Four large electric cars has been engaged and the entire party was taken over the famous "Gorge Route." This route takes in the Falls, and traverses the very high bluffs on the Canadian side. Returning the track follows along the foot of the cliffs on the American side, giving a magnificent view of the whirpool and rapids below the falls.

Returning from the trip, the members of the party were the guests of the Ramapo Iron Works at its Buffalo Plant. An excellent and ample luncheon was served in a large tent specially erected for the purpose by the Ramapo Iron Works. After the luncheon, a trip was made through the frog and switch shops, and the party returned to Buffalo.

The retiring president, A. M. Clough was presented with a handsome silver set by W. C. Kidd, in behalf of the members of the Track Supply and Roadmaster's Associations.

The election of officers took place Thursday morning, and resulted as follows:

President, Wm. Shea, roadmaster C. M. & St. P. Ry.

1st Vice-President, M. Donahue, roadmaster B. & O., (re-elected).

2nd Vice-President, W. R. Thompson, roadmaster Central of Georgia.

Secretary and Treasurer, L. C. Ryan, roadmaster, C. & N. W. Ry. (re-elected).

THE FAITHFUL SECTION FOREMAN.

By A. M. Clough, Supv. N. Y. C. & H. R. R. R.

The telephone was ringing, he got up and said "Hello."
The rain and hail was falling fast; the wind did fiercely blow.
The fellow at the other end, he told him, without fail,
To hurry out and get his men; there was a broken rail.

The faithful Section Foreman got up and took his light,
And hurried to his section, in the middle of the night
He did not mind the storm, or the fierceness of the rain.
He knew right well that he must go and fix his track again.

He's like a watchful shepherd, his mind is everywhere,
Always thinking of his track to keep it in repair.
But people when they travel (each in his easy chair)
Don't realize their lives are in the Section Foreman's care.

He has to watch himself and men as the trains are passing by,
And no defect in the track will escape his watchful eye.
His qualities are much above the average of men—
He's always true and faithful to the trust reposed in him.

The public should appreciate his work both night and day
Its safety is his watchword, regardless of his pay.
He is ever ready to respond, was never known to fail—
Just as the night when he was called to fix the broken rail.

Personals

T. V. Thaggard has been appointed terminal roadmaster of the Texas & Pacific, with office at New Orleans, La.

L. P. Mase has been appointed signal supervisor of the electric division, New York Central & Hudson River, with office at New York, succeeding M. W. Bennett, transferred.

Howell H. Althouse, formerly principal assistant engineer of the Erie, has been appointed chief engineer, with office at New York.

G. C. Cleveland, formerly assistant chief engineer of the Lake Shore & Michigan Southern, has been appointed chief engineer, office at Cleveland, O. R. O. Rote, formerly principal assistant engineer, has been appointed assistant chief engineer, with office at Cleveland, succeeding G. C. Cleveland.

Joseph Mullen has been appointed engineer maintenance of way of the Cleveland, Cincinnati, Chicago & St. Louis, with headquarters at Galion, O., succeeding Paul Hamilton, promoted. W. C. Kegler has been appointed engineer maintenance of way, with headquarters at Mattoon, Ill., vice Joseph Mullen. C. W. Cochran has been appointed engineer maintenance of way, with headquarters at Mt. Carmel, Ill., vice W. C. Kegler. Paul Hamilton has been appointed engineer of track and roadway, with headquarters at Cincinnati, O., vice C. S. Millard, promoted.

J. Emerling, supervisor of the Pennsylvania at Salamanca, N. Y., has been transferred to South Oil City, Pa., succeeding R. B. Harris. H. A. John, Jr., supervisor at New Bethlehem, Pa., succeeds J. Emerling at Salamanca N. Y. R. B. Harris succeeds H. A. John, with office at New Bethlehem.

Alexander Bonnyman, formerly general manager, has been appointed chief engineer of the Atlanta, Birmingham & Atlantic, office at Atlanta, Ga.

J. D. Farrington has been appointed roadmaster of the Chicago, Burlington & Quincy, with office at Aurora, Ill., succeeding C. F. Bowers, promoted.

C. Lindsay, roadmaster of the Ann Harbor, has been transferred from Cadillac to Alma, Mich. J. O. Laughlin, roadmaster at Owosso, Mich., has resigned. L. J. Allen has been appointed roadmaster, with office at Ann Harbor, Mich.

Wm. Turner has resigned as roadmaster of the Atchison, Topeka & Santa Fe at Arkansas City, Kan. T. A. Moore has been appointed roadmaster at Williams, Ariz., succeeding Charles Johnson.

O. T. Nelson, formerly roadmaster of the Atlantic & West Point, has been appointed superintendent maintenance of way, with office at Montgomery, Ala.

E. N. Rodrick has resigned as roadmaster of the Atlantic Coast Line at Lakeland, Fla. J. A. Butler has been appointed roadmaster at Lakeland, Fla.

D. B. McKenzie has been appointed chief engineer of the Birmingham & Southeastern, with office at Union Springs, Ala., succeeding W. A. Garrott.

J .T. Martin has resigned as supervisor of bridges and buildings of the Chicago & Alton. F. M. Corbett has resigned as supervisor of bridges and buildings at Springfield, Ill. R. J. Watson has been appointed assistant engineer, and G. L. Barklay has been appointed assistant engineer, both with offices at Springfield, Ill. Marion Morris has been appointed signal supervisor at Marshall, Miss., succeeding T. Rumans. M. Donahoe has had his title changed from general supervisor of roadway and structures to roadmaster, office at Bloomington, Ill. Wm. Pitcher has been appointed general foreman of bridges and buildings, with office at Bloomington, Ill.

G. Algren, roadmaster of the Chicago Great Western at Red Wing, Minn., has been transferred to St. Paul, Minn., G. Larson has been appointed roadmaster at Red Wing, Minn., and T. McCormick has been appointed roadmaster at Dubuque, Ia.

W. E. Duckett has resigned as assistant engineer of the Chicago, Milwaukee & St. Paul at Ottumwa Jct., Ia. J. C. Null, formerly signal inspector, has been appointed assistant signal engineer, with office at Milwaukee, Wis., succeeding H. K. Lowry. L. B. Porter, A. Breecher and M. J. Plumb have been apopinted signal inspectors, with headquarters at Milwaukee, Wis.

J. Dulin has resigned as roadmaster of the Chicago, Rock Island & Pacific at Oskaloosa, Ia. H. Berend has been appointed roadmaster at Eldon, Ia. T. S. Farquarson, roadmaster at Fairbury, Neb., has resigned. G. Flora, roadmaster at Sibley, Ia., has been transferred to Estherville, Ia., succeeding W. A. Shaffer. E. R. Flora, roadmaster at Chicago, and G. M. Greene, roadmaster at Armourdale, Kan., have resigned. T. W. Brown has been appointed roadmaster at Washington, Ia., and L. Brien has been appointed roadmaster at Fairbury, Neb. J. Sullivan has resigned as roadmaster at Des Moines. J. A. Tainor, formerly roadmaster at Little Rock, has been transferred to Booneville, Ark. A. Shumate has been appointed roadmaster at Pratt, Kan.

Maro Johnson has been appointed assistant engineer of bridges of the Illinois Central and Yazoo & Mississippi Valley, with headquarters in Chicago.

C. N. Kalk has been appointed chief engineer of the Minneapolis, St. Paul & Sault Ste. Marie, with office at Minneapolis, Minn.

T. J. Burke, supervisor of the Lehigh Valley, has been appointed division engineer with office at Auburn, N. Y., appointment to take effect October 15.

Elmer H. Olson has been appointed assistant engineer of the Gulf, Colorado & Santa Fe at Galveston, Tex., succeeding P. J. Carter, resigned.

The Kansas City, Mexico & Orient will build a new passenger station at Sweetwater, Tex., within three months.

The Manistee & Repton has completed an extension to Monroeville and plans a further extension of three miles to Monroe. When this is completed it is expected to begin on an 8-mile extension south from Snider. It is then planned to take up the road from Snider to Manistee and from Conoly to Manistee Junction. This will leave a road running in a southerly direction from Monroe, Ala., towards Bay Minette or Mobile.

The Missouri, Kansas & Texas will begin work shortly on car repair shops and a water treating plant at East Waco, Tex.

With The Manufacturers

TRACK SUPPLY ASSOCIATION.

The Track Supply Association held its annual meeting and exhibition of railway appliances in connection with the convention of the Roadmasters' and Maintenance of Way Association. The meeting showed a very prosperous condition of affairs. The number of firms represented and the number of exhibits was considerably above that of previous years.

The following were elected officers of the Track Supply Association for the ensuing year: A. H. Weston, president, Lackawanna Steel Company; Walter Allen, vice-president, Pennsylvania Steel Company; W. C. Kidd, secretary and treasurer, Ramapo Iron Works; members of executive committee, E. M. Fisher, Fairbanks-Morse & Co.; W. J. Fairbank, Elliot Frog and Switch Co.

The officials for 1912 are to be especially commended for the showing of the association. The officers were: W. C. Kidd (Ramapo Iron Works). president; A. H. Weston (Lackawanna Steel Co.), 1st vice-president, Walter H. Allen, 2nd vice-president Lackawanna Steel Co.; F. A. Preston (P. & M. Co.), secretary and treasurer.

W. C. Kidd was especially active also in helping out the officers of the Roadmasters' Association, and deserves a good deal of credit for his endeavors to make both meetings a success.

The following firms exhibited.

Ajax Forge Company, Chicago.—Ajax manganese guard rail. Representatives Mr. Elfberg and H. C. Hutchins.

Alex. Milburn Company, Baltimore.—Acetylene lights. Representative, Mr. Pollard.

American Guard Rail Fastener Company, Philadelphia.—Guard rail clamps and rail benders. Representative D. F. Vaughan.

American Hoist and Derrick Company, St. Paul.—Transparencies of American ditcher in operation. Representatives Ed. Coleman and Geo. Haight.

American Valve and Meter Company, Cincinnati.—Switch stands and safety switch locks. Representatives J. T. McGarry and F. C. Anderson.

Jas. C. Barr, Boston.—Brown rail unloader. Representatives J. C. Barr and R. H. Anthony.

Buffalo Forge Company, Buffalo.—Forges. Representative J. G. Leonard.

Carnegie Steel Company, Pittsburgh.—Carnegie steel tie and Duquesne rail joints. Representatives N. C. Hench, F. C. Deming and S. G. Ellis.

Chicago Pneumatic Tool Company, Chicago.—Section motor car. Representatives Chas E. Walker, J. W. McCook, Ross Watson and Thomas Aldcorn.

Chicago Steel Railway Tie Company, Chicago.—Section of steel tie track. Representative J. Alvin Hyle.

Dorpmueller Co., New York.—Creep checks and combined tie plate and anti creeper. Representatives A. Dinklage, J. C. Barr and R. H. Anthony.

Fairbanks, Morse & Co., Chicago.—Section motor car. Representatives E. M. Fisher, D. J. Higgins, F. H. Douglas, Geo. Akers, and R. H. Connard.

Fairmont Engine Company, Fairmont, Minn.—Literature. (The exhibit of this firm was held up in transit for several weeks and did not arrive in time for the exhibit.) Representative Mr. Wade.

Hayes Track Appliance Company, Richmond, Ind.—Hayes derails. Representatives E. T. Ruby and S. W. Wallace.

Hobart-Allfree Co., Chicago.—Derailers. Representative W. H. England.

Hubbard & Co.—Track tools. Representative E. L. Mason.

John Gearon, Sr., Chicago.—Steel tie. Representatives John Gearon, Sr., Edward Gearon and M. V. Gearon.

Joyce-Cridland Co., Dayton, Ohio.—Track jacks. Representative Chas. D. Derby.

Indianapolis Switch & Frog Company, Springfield, Ohio.—Switch stands, manganese switch points, models of manganese frogs and crossings. Representative E. C. Price.

Lackawanna Steel Company, Buffalo.—Abbott joint plates and hook shoulder tie plates. Representative A. H. Weston.

M. W. Supply Company, Philadelphia.—Vaughan rail anchors, foot guards and splice straighteners. Representative David L. Vaughan.

National Lock Washer Company, Newark, N. Y.—Nut locks. Representative Mr. Seymour.

National Malleable Castings Company, Cleveland.—Tie plates, rail anchors and anti-creepers. Representatives J. W. Stevenson, C. L. Johnson, L. S. Wright, Tom Aishton and Geo. B. Martin.

Associated Manufacturers Company, Waterloo, Iowa.—Handcar engines. Representative M. Cummings.

P. & M. Co., Chicago.—Rail anchors, tie renewers, bond wire protectors, crane guard rail retainers. Representatives F. A. Preston, Geo. Johnson, D. T. Hulberg, J. Hubbell and L. W. Kent.

Pennsylvania Steel Company, Streelton, Pa.—New Century switch stands; Mayori nickel chrome steel heat treated frog bolts. Representatives W. H. Allen, H. Barbee, Elmore DeWitt, D. Salsich, Stanley Smith, G. S. Vichery and C. A. Alden.

Postive Rail Anchor Company, Louisville, Ky.—Positive rail anchor and tie plate; economy switch points. Representatives W. M. Mitchell, J. C. Haswell, R. H. Johnson and J. C. Long.

Pratt & Letchworth Co., Buffalo.—Literature only.

Q. & C. Co., New York.—Bonzano rail joint, Bonzano rolled step joint, Vaughn anti-creeper, Q. & C. special guard rail clamp, tension guard rail clamp. Representative, J. A. Bodkin.

Rail Joint Company, New York.—Continuous, Weber and Wolhaupter joints. Representatives Geo. Isbester, Wm. E. Clark, Mr. Holloway, Mr. Boyce, R. Smith, Mr. Chapman and Chas. Jenkinson.

Railroad Supply Company, Chicago.—Tie plates. Representative M. J. Comerford.

Ramapo Iron Works, Hilburn, N. Y.—Switch stands. Representatives J. E. Davidson, Arthur Germunter and W. C. Kidd.

Railway Age Gazette, New York.—Copies of *Railway Age Gazette and Signal Engineer.* Representatives C. R. Mills and E. T. Howson.

Railway List Company, Chicago.—Copies of *Railway Engineering and Maintenance of Way* and *The Monthly Official Railway List.* Representatives C. S. Myers, J. M. Crowe and K. L. Van Auken.

Southern Railway Supply Company, St. Louis.—Saunders corrugated car stopper. Representatitves M. E. Towner and W. D. Achoff.

Vaughn Rail Support Company, St. Louis.—Rail supports. Representative T. E. Vaughn.

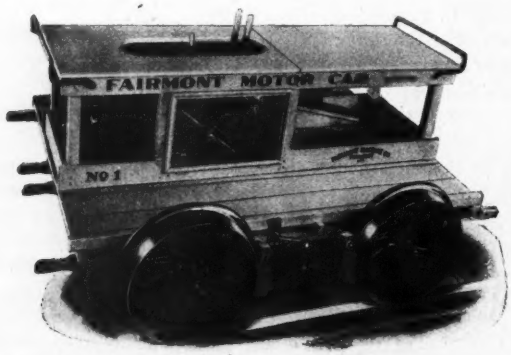
Henry Ware, Springfield, N. Y.—Ware improved tie plate gage and tie surfacer. Representative Henry Ware.

Walter McLeod & Co., Cincinnati.—Carbide lights. Representative Wm. Hext.

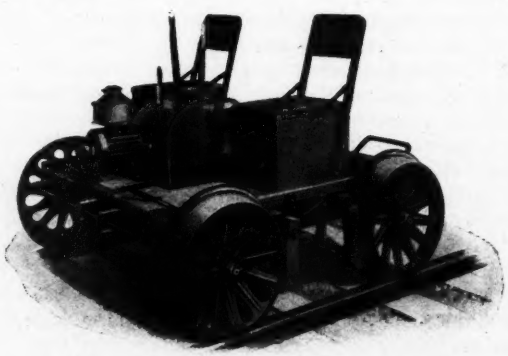
FAIRMONT HANDCAR ENGINES AND MOTOR CARS.

The Fairmont Machine Company is manufacturing a gasoline engine to install on section handcars, which has given great satisfaction to numerous section men and roadmasters. There are a good many reasons given for the favor with which the engine has been received, the principal one of which is probably its simplicity. It is made up of an exceedingly small number of parts, and still has many exclusive features.

The makers of this machine guarantee it to develop the greatest possible power, and also to operate with a saving of one-third in gasoline. The high power developed and the saving in gasoline is made possible by the "hit and miss" governor, which has exclusive features, and the high class bearings, with exceptional facilities for keeping same well lubricated. The special feature of this governor is that it gets an explosion for each revolution of the wheels when under full load. Practically all other governors of this type make an explosion every second revolution. By receiving the impulse every revolution the most effective power is produced, and there is no loss in friction from idle



Fairmont Motor Car for Section Crews.



New Fairmont Motor Car for Roadmasters.

movements of the piston and idle revolutions of the engine. This feature accounts for the high ratio of actual power developed as compared with rated H. P. Under light load the Fairmont engine automatically cuts off both gasoline and battery. Every charge admitted into the cylinder is a maximum charge, and the mixture of air and gasoline is thus always perfect. The advantage is that the governor regulates the number of maximum impulse charges, which is claimed to be much more effective than to have the number of explosions fixed, and vary only the size of the charge. It has been shown to be a fact that in the operation of practically all engines, the maximum efficiency, i. e., the cheapest power, is developed with the engine under full load. With the engine described herein the load on the engine is always kept at the maximum by regulating the number of explosions.

There are no cylinder valves to leak power; no gears, cams, push rods or eccentrics, on this machine, to wear out, get loose or break. The timing of the spark is done by one single moving part, not by four or five.

The cylinder has been made perfectly tight by eliminating the rotative igniter extending into the explosive chamber, and the exhaust and air valves. The result is a perfectly tight cylinder; there is no loss of power through leakage in the cylinder.

The Fairmont engine is made for installation on an ordinary section handcar. The engine sets on a patented sliding base, and has a belt drive. When the engine is being started, it is moved ahead so that the belt is slack. After being started, the engine is forced back against the belt, and starts the car. No trouble is experienced with the belt contracting or stretching on account of the weather. The sliding base makes the drive entirely independent of such changes in the belt length.

A maintenance of way official on one of the trunk lines was recently appointed to make tests and an investigation of the engine described herein, by the general officials. His report contained the following information:

"I thoroughly inspected and tested the engine. It hauled five of us up a 3 per cent grade without any effort whatever. On level track a steady gait of 18 miles per hour was maintained. At a speed of 5 miles per hour the engine propelled us up a 7 per cent grade (into coal house) about 400 ft. long. These tests convince me that the engine runs as fast as practicable with a section crew, and slow enough to make a thorough handcar inspection. I believe this engine to be the best I have ever investigated and I have made a thorough study of a great number, and I give herewith reasons for my opinion.

1. It is very neat and compact, is well made, and has few wearing parts.

2. It is a horizontal engine, and vibrations will not shake the car to pieces.

3. There are only two bearings to be watched by the operator. These are the two bearings on the crank shaft. They are long and well bushed and well lubricated by two hard oil cups. The bearings at end of piston rod are kept well oiled by lubricant which is mixed with the gasoline.

4. The engine is of the two cycle type, with no valves to bother with.

5. The water tank is separate and easily detached from the cylinder by loosening one burr, and it takes but one gallon of water. This is important, as it is lighter and is deemed to be more efficient than an air cooled engine and is guaranteed against breakage from freezing.

6. The engine is mounted on a plank and can be easily installed on a handcar.

7. The engine can be started without starting the car.

8. The spark contact works automatically as follows: Operator moves lever one way and spark contact is made at every revolution of fly wheel. Operator moves lever in opposite direction, and spark contact is made just often enough to maintain a steady gait.

9. Engine is provided with two sized drive pulleys, easily changed, giving two speeds, one for pulling a heavy load and one for speed.

10. Power is conveyed by 4-in. belt running over full flanged pulley on engine and larger non-flanged wood split pulley on axle of handcar.

11. The wood pulley is installed by moving small pinion

wheel on handcar axle to one side and putting the split wood pulley on.

12. The engine has a high class automatic carburetor easily adjusted to all conditions.

13. The engine can be reversed independent of the car by use of the reverse lever.

14. The engine can be controlled in every way by a non-complicated set of three levers.

15. The engine has reverse power to handle on any ordinary grade, any load which the section foreman can handle without a work train.

16. The car can be run in either direction without being turned.

17. The weight is only 200 lbs., so balanced that the car is easier to handle than an ordinary handcar.

18. The engine, being on a sliding base, can be slid out in an instant for repair.

19. It is so simple and has such few parts that any foreman can be taught how to run it in a few minutes. It is shipped in such shape that it can be installed by any foreman.

The Fairmont Machine Company, Fairmont, Minn., manufactures the engine described herein. This Company also manufactures a complete motor car with an engine exactly similar to the one described, and in two styles, one for section work and one especially adapted for road masters' inspection work, being short so that it will go in any baggage car door. The seats being reversible the rider faces the front when going either way without turning the car around. This Roadmasters car is strictly a new design and has just been put on the market.

IMPROVED GIBRALTAR BUMPING POST.

The Gibraltar Bumping Post has recently been designed with an entirely new feature. Instead of the cast iron head there has been substituted a malleable iron casing, carrying the McCord draft gear, consisting of steel levers and spring with a capacity to take an impact of 300,000 lbs.

It is very desirable that a bumping post, if possible, be so designed that it will stop a car or train with the least injury both to the post and the car, and the feature described would seem to offer a solution of the problem. The spring has been made of the same or greater capacity than that of the draft gear of a car, and this fact should insure stopping a car without injury, going at any reasonable speed.

The post described has been specially designed to meet the service conditions which exist at so many points where a post must be in constant use, and where the element of time is so important that train men cannot approach a dead end cautiously and carefully. A post located at such a place must be of sufficient strength and capacity to take the hard knocks it is sure to receive. This post, it is claimed, has met successfully the service conditions described, standing up for seven months where other posts had been knocked out on an average of one in two weeks. It is assembled all ready for installation when it leaves the factory, and can be placed in service at very low cost; has no wooden parts to splinter or decay, insuring length of service and small cost of maintenance; can be applied to ground rails or for trestle service with equal facility.

Improved Gibraltar Bumping Post.

It is not necessary to dig a deep hole under the track for the foundation or to anchor the posts. The anchoring beam is a 9-inch, 21-lb. I-beam, 10 feet long, placed longitudinally directly beneath the ties. Any tendency of the post or track to rise is resisted by the weight of the track and the car which hits the post.

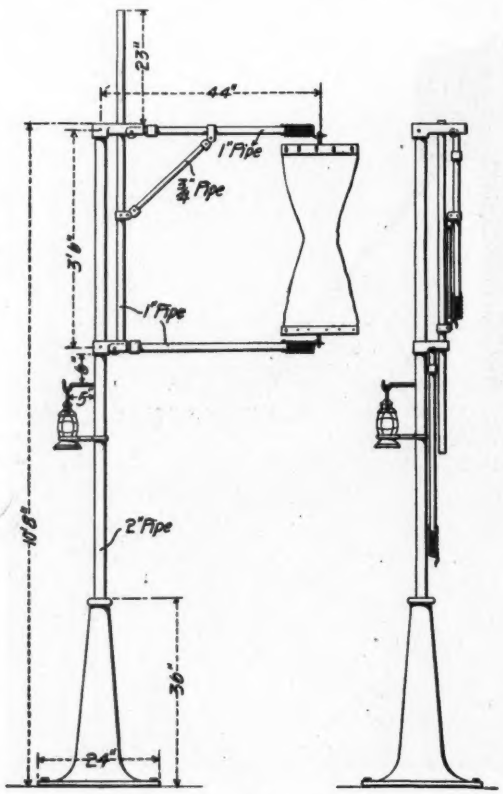
The improved Gibraltar bumping post is marketed by the Gibraltar Manufacturing Co., 1919 People's Gas Building, Chicago.

BARKER MAIL CRANE.

The mail crane question is one of which very little is heard for the reason that the field is somewhat limited and the general expectation is that sooner or later there will be one general device that will both take on and put off the mail, but it will be some time yet before such a device, which is entirely satisfactory to both the government and the railroads, is generally adopted. In the meantime the expense of keeping up cranes is quite a large item, as it is surprising how often cranes that need any adjustment of the hooks that hold the pouches need attention.

A number of roads are building wooden cranes in their own shops, but there is an all-iron crane on the market known as the "Barker Crane" that is said to be cheaper and better than the wooden crane.

As may be noticed by the illustration, this crane is made of a cast base, two-inch iron pipe mast, with malleable iron



Barker Mail Crane.

castings for sockets for arms. The castings on the arms are steel and the coil springs on the ends of the arm are ¼ inch spring steel. These springs need no adjustment and the crane is so simple there is nothing to get out of order and it lasts for years.

The lower arm supports the upper one and the pouch supports them both. When the pouch is grasped by the catcher the springs give sideways or any way the pull comes and the pouch slips off easily without damage either to pouch or crane.

The crane is painted two coats and may be set up in an hour. It is the standard crane of the C., M. & St. P., C. M. & P. S., Northern Pacific, Union Pacific, Southern Pacific; in fact, all the Harriman Lines, including the Illinois Central and over 30 other roads.

The crane described above is manufactured by the Barker Mail Crane Co., of Clinton, Iowa.

The El Paso & Southwestern has completed track laying from Fairbanks, Ariz., for a distance of 40 miles to Cienega Creek, on the extension building from Fairbanks to Tucson, 66 miles. Track laying on the remaining 26 miles to Tucson will be delayed until about October 1, when it is expected that the bridge over Cienega Creek will be finished.

The Delaware, Lackawanna & Western will in a few days submit plans to the Grade Crossing Commission of Syracuse for the elimination of its grade crossings in that city. It is understood that the expense of elevating the tracks, the construction of a new freight depot and passenger station and the necessary improvements in the yards will approximate $1,500,000.

Officials of the Denver, Laramie & Northwestern are to ask the District Court for permission to issue $200,000 of receiver's certificates to complete the extension to Severance, Colo.

The Gulf, Texas & Western has grading work about half finished on the extension from Jacksboro, Tex., south to Salesville, 23 miles. The Texas Building Company, Fort Worth, has the contract.

It is believed that the Greenville & Knoxville, W. H. Patterson, President, Atlanta, Ga., will begin work shortly on its projected extension from its present terminus at Drakes toward Knoxville.

The Houston & Texas Central has let contracts to complete the cut-off from Stone City, Tex., southwest, to Giddings, about 40 miles. The grading is about half finished.

The Jonesboro, Lake City & Eastern, R. E. L. Wilson, president, Memphis, Tenn., is reported to be planning to begin construction work this fall on an extension from Wilson, Ark., to Memphis, Tenn. Practically all right of way for this extension has been obtained. This company is also planning an extension from Jonesboro to Newport, Ark., but construction on this will probably not be undertaken soon.

The La Salle County has work near completion on a line from Mendota, Ill., southeast via Prairie Center and Wallace Center to Ottawa, about 20 miles. The company will use both steam and electricity for motive power. G. H. Dodge, 1511 Dearborn street, Chicago, president.

The Lehigh Valley has given a contract to the Miles Tighe Construction Co., Easton, Pa., for laying five miles of third-track and five miles of fourth-track between South Somerville, N. J., and Flagtown. A contract has also been given to the J. A. Kelley Co., Philadelphia, Pa., for five miles of third-track from Three Bridges, N. J., to Stanton, also for 10 miles of third-track from P. & L. Junction to Stafford, N. Y.

The Louisiana & Arkansas has given the general contract to M. Tansey, Jena, La., and a sub-contract has been given to the List & Gifford Construction Co., Kansas City, Mo., to build from Jena, La., to Jonesville, about 20 miles. The work involves moving 800,00 cu. yds. of earth. There will be one 354-ft. steel bridge over Little River, and another 825-ft. steel bridge over Black River. William Buchanan, Texarkana, Ark., president.

Construction work will be started at once on the Multnomah Central. Surveys are all made from Cottrell to Salmon River, and the contract for construction has been awarded to Twohy Brothers Co. of Portland. The offices of the Multnomah Central Rv. Co. are in the Railway Exchange, Portland, Ore., E. R. Ernsgerber, president.

REINFORCED CONCRETE COALING STATION, B. & O. R. R.

The illustration herewith shows a large 600-ton capacity, four track, Holmen reinforced concrete locomotive coaling station, which has just been put in service for the Baltimore & Ohio at La Paz Junction, Indiana.

In 1909 this company contracted with the Roberts & Schaefer Co. for a similar plant which they operated for about two years at Sir John's Run, W. Va. After this trial a contract was closed for three duplicates, the cost of which was approximately $75,000.00. The other two plants were built at Warwick, Ohio, and Rowlesburg, W. Va.

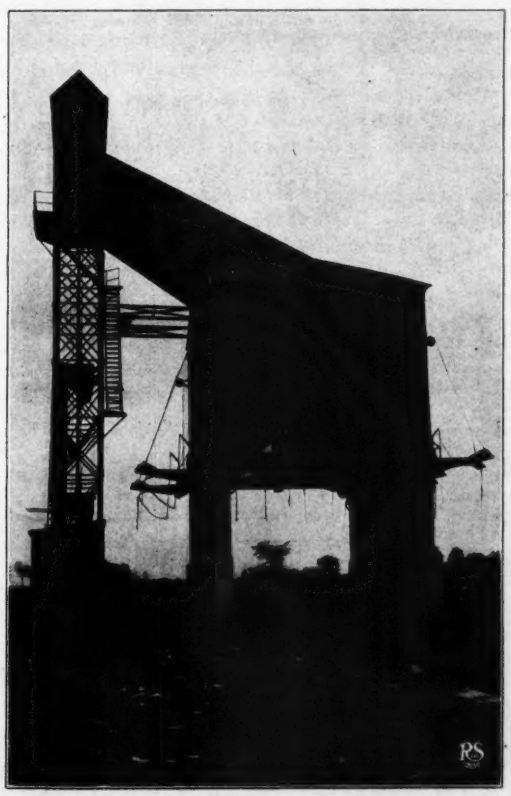
The La Paz station shown in the cut herewith is designed to coal on four coaling tracks, the two main line tracks passing under the coaling plant with main line clearance. The receiving track is located at the side and the coal is discharged into a 20-ft. concrete track hopper. This hopper has a sidewalk finish of 1 inch neat cement.

The track girders are 24-inch 80-lb. I-beams and are equipped with malleable iron rail clips for securing rails to the girders.

In front of the track hopper are two Barrett patented revolving measuring feeders for supplying coal automatically to the Holmen coal buckets. These feeders measure exactly 2½ tons of coal from the track hopper into the bucket, preventing overflowing the bucket and flooding the pit. They are actuated by the ascent and descent of the elevating bucket. Two buckets, which operate in a structural steel tower, have an elevating capacity of 150 tons per hour and discharge their coal automatically into the 600-ton reinforced concrete coal pocket shown. The coal pockets are equipped with undercut gates and heavy hooded apron fixtures for delivery of coal to the locomotives on four tracks.

The bin is designed with collision walls at the side of the two main line tracks to prevent injury to the bin columns in the event of a derailed car.

The Roberts & Schaefer Co., Chicago, designed and constructed the plant described herein.



Reinforced Concrete Coaling Station, B. & O. R. R.

Industrial Notes

The officers of the Hall Railway Signal Co., New York, are now as follows: President, J. J. Kennedy; vice-president, William P. Hall; treasurer, N. J. Brown; secretary, E. P. Goetz. Mr. Kennedy was vice-president and treasurer of the Hall Signal Co. before its reorganization, and Mr. Hall was president of that company.

The Cincinnati Railway Club has been organized at Cincinnati and will hold meetings the second Tuesday of February, May, August and September. The members of the club include many of the prominent railway officials of the central West. The officers are: President, R. C. Barnard, superintendent Pennsylvania Lines West; first vice-president, J. Paul Stevens, general superintendent Chesapeake & Ohio; second vice-president, W. H. Dooley, superintendent motive power, C. N. O. & T. P.; Treasurer, Wm. Holmes, Galena Signal Oil Co.; secretary, H. Boutet.

The Buffalo, Rochester & Pittsburg has placed an order with the Western Electric Co. for equipment for 125 miles of telephone train dispatching circuits on the Middle & Pittsburg Divisions. This company has ordered another Brown hoist from the Brown Hoisting Machinery Co., and another American railroad ditcher from the American Hoist & Derrick Co.

The Link Belt Co., Chicago, is reported to have decided to build an addition to its foundry, 100x450 ft., on West Thirty-ninth street, and will be in the market for considerable new foundry equipment.

W. O. Jacquette, formerly vice-president of Manning, Maxwell & Moore, Inc., New York, has been made vice-president of the American Shop Equipment Co., Chicago, with office at 30 Church street, New York.

Morgan T. Jones Co., inspecting and consulting engineers, Monadnock block, Chicago, announce the appointment of Mr. P. E. Stevens, as manager of the structural steel and cement departments with headquarters in Chicago, vice Mr. James A. Lister. Mr. Stevens was formerly connected with the engineering department of the Great Northern Ry. and has lately been bridge engineer for the city of St. Paul, Minn.

The Western Electric Co., New York, has taken over the business of the Cleveland Electrical Supply Co., Cleveland, Ohio, and has opened a branch office at 724 Prospect avenue, Cleveland, the former address of the supply company. H. A. Speh, formerly in the Buffalo, N. Y., office of the Western Electric Company, has been made manager.

The name of the Hall Railway Signal Co., New York, successor to the Hall Signal Co. has been changed to the Hall Switch & Signal Co.

The Wharton Jr. Co., has been merged with the Taylor Iron & Steel Co., of High Bridge, N. J., the name of the new company to be the Taylor, Wharton Iron & Steel Co. Knox Taylor is president of the new company.

The Preston Car & Coach Co., Preston, Ont., has secured the Canadian manufacturing rights of some gasoline electric cars recently tried out on the Canadian Northern.

The Union Switch & Signal Co. has declared a regular quarterly dividend of three per cent on the common and preferred stocks, payable October 10.

The Westinghouse Air Brake Co. has declared a regular quarterly dividend of two per cent and an extra dividend of two per cent, payable October 15.

The Canadian Locomotive Co., Kingston, Ont., has increased the capacity of its plant from five to 18 locomotives per month.

The Chesapeake & Ohio has 26 spans of released bridges for sale, running in lengths from 18 ft. 6 in. to 112 ft. Information may be obtained from B. T. Jellison, purchasing agent, Richmond, Va.

Recent Engineering and Maintenance of Way Patents

SIGNAL-LAMP.

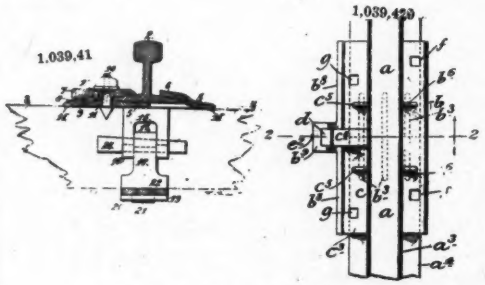
1,039,123—William S. Hamm, Hubbard Woods, Ill., assignor to The Adams & Westlake Company.

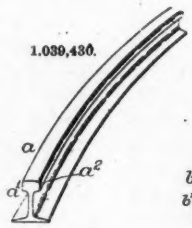
This is an upper draft lamp, having in combination, a dome having induction ports, a square screen depending from the dome into the body of the lamp, a square upwardly-tapering flue extending upwardly from the base of the screen, a plate extending inwardly from the dome above its induction ports, and perforated baffle plates extending downwardly from the last-named plate and joining the corners of the screen and the flue.

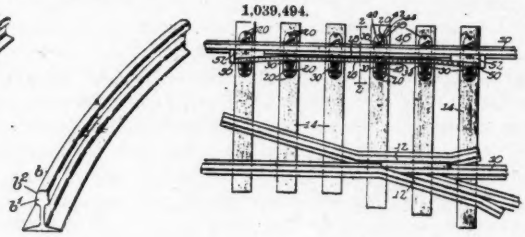
AUTOMATIC RAIL-FASTENER.

1,039,362—Arthur C. Candland, Provo, Utah.

This is a railway tie and fastener consisting of extended lugs cut from the sides of an upturned metal channel each of said lugs having an opening longitudinal cut therein with its ends widened outwardly by beveled cuts, the slots adapted to receive locking blocks and the beveled cuts to form a seating mortise; a key adapted to seat in said mortise; bell crank levers pivoted to the sides of said metal channel; depending arms thereon beveled toward said channel; wedges having their side edges formed at an opposed angle to that on said bell crank levers; clamps transversely fitted in said channel having a portion of each bent to engage the base flange of a rail; cushion blocks to support a rail above said lugs; and a locking block between said rail and each of said wedges.







CUSHION-HEAD FOR CONCRETE PILES.

1,039,369—Albert R. Eichler, Sacramento, Cal.

This is a cushion head for piles, comprising a metallic jacket, a hard-wood block inclosed in the jacket and secured thereto, said jacket extending beyond the ends of the block, a resilient plate on the upper end of the block surrounded by the jacket, and a layer of soft wood on the lower end of the block surrounded by the jacket.

RAIL-FASTENING.

William E. Franklin, Crossnore, N. C.

This is a railway track structure, which has in combination with a pair of spaced parallel rail sections, a transverse member having slots for respectively receiving said sections, one side of the member being formed with an inclined groove, an element disposed in one of the slots of the member against the inner wall thereof for receiving a respective rail section, a wedge-shaped rail clamp disposed within the last mentioned slot and between the outer wall thereof and the rail section, the smaller end of the clamp being formed with an opening registering with the groove of the transverse member, said clamp and member being respectively movable one with the other, and a wedge-shaped key disposed within said opening and slot for locking the member, element and rail section against internal movement.

MEANS FOR SECURING RAILS TO TIES.

1,039,417—John W. Kummer and George Jorgensen, Vancouver, British Columbia, Canada.

This is a means for securing a rail to a tie, said means comprising a plate of sheet metal having a portion on one side of the rail seat sheared along the sides nearer to the rail seat and bent upward to engage the upper side of the rail flange, a similar sheared portion on the other side of the rail seat bent upwardly a short distance only above the face of the plate, a clamp member designed to bear on the rail flange and having at the other end abutment notches to engage the edge of the upwardly bent portions of the plate and an elongated aperture to take a bolt passed through a square aperture in the plate close to the flange, and means for securing the seat plate to the under side of the tie.

RAILWAY-RAIL COUPLING.

1,039,429—Frank McCue, New York, and Frederick E. McCrea, Troy, N. Y. Filed Jan. 20, 1912.

This is a railway rail coupling comprising a base plate provided at one side with an integral angle plate that overlaps the base flanges at one side of the rails and abuts against the webs thereof, a separate angle plate which overlaps the base flanges of the rails at the opposite side and abuts against the webs thereof, said separate plate being provided centrally thereof with a transverse shoulder, and said base plate being provided with a raised keeper adapted to receive a nut placed loosely therein, the outer wall of said keeper being provided with an aperture; a screw is passed loosely through said aperture and through said nut and adapted to bear on said shoulder, the outer end of said screw being provided with an angular head of less dimensions than said aperture, and which is inclosed by the outer wall of the keeper when the screw is in operation.

RAILROAD TRACK CURVE.

1,039,430—John William McManama, Waltham, Mass., assignor of one-third to Samuel W. Simonds, Somerville, Mass., and one-third to Francis A. Barbey, Cambridge, Mass.

This is a railroad track curve the rails of which have tread faces of different widths, the tread face of the inner rail being narrower than the tread face of the outer rail to minimize the frictional resistance to side slip of wheels running on the inner rail, the depth of the head of the inner rail being greater than that of a rail head of standard depth, to increase the extent of safe wear of the inner rail, and compensate for the reduction of the width of the tread face of the inner rail, and for the increased weight of the rolling stock sustained by the inner rail.

GUARD-RAIL.

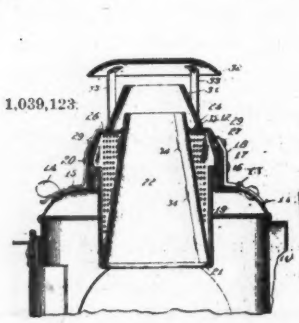
1,039,494—Dennis H. Cusic, Chicago Heights, Ill., assignor to Morden Frog & Crossing Works, Chicago, Ill.

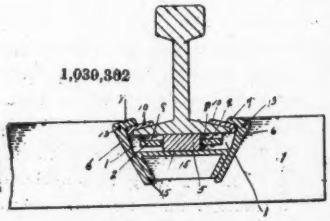
This is a guard which has in combination with a main rail, a plurality of chairs rigidly secured adjacent thereto, a side flange near its lower edge placed with said flange entering recesses in the chairs, lugs projecting from the rail into recesses in the chairs, and means connecting the lugs to the chairs.

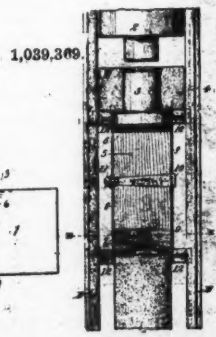
The Union Pacific has given a contract to Kilpatrick Brothers & Collins, of Omaha, Neb., to build the Hastings & Northwestern from Hastings, Neb., northwest to Gibbon, 26 miles.

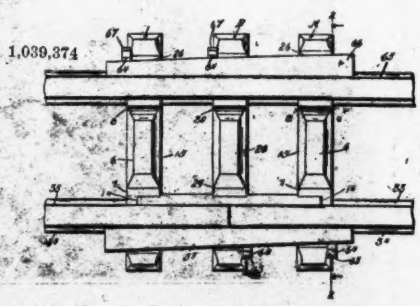
The Railroad Committee of El Paso, White county, Ark., is reported to have raised $10,000 together with right-of-way through the county and depot grounds for a railroad from that city. It is reported that Col. C. C. Godman, railroad contractor, Fort Smith, Ark., will undertake the construction of the line.

According to reports, work has been finished by the Wichita Falls & Northwestern on the extension to Forgan, Beaver county, Okla., which is 85 miles northwest of Woodward.









New Dixon Railroad Booklet

We have just prepared a booklet treating of the various Dixon graphite products for use on the railroad. The entire Dixon railroad line is treated of and all other matters excluded—this booklet is of interest only to the various mechanical railroad departments.

The application of dry graphite for lubrication, the use of Dixon's graphite greases, Dixon's Silica-Graphite Paint, crucibles, facings, crayons, etc., is all included in this booklet—a total of 40 pages. There is bound to be some matter to interest you here.

We have tried to make our booklet attractive in appearance as well as interesting to read, and to this end have included views taken of railroad stations and yards, stretches of track, signals, bridges, etc.

Write for copy of this booklet by number 187 R. R.

Joseph Dixon Crucible Co.

Jersey City, N. J.

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Noted for Simplicity, Strength and Lasting Qualities. Adapted to all positions.

Mechanical Mfg. Co.,
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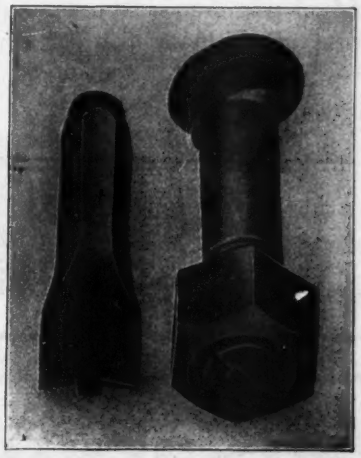

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Practical Switch Work

By D. H. LOVELL
Division Superintendent Pennsylvania Ry.

An Instructor and Guide for Roadmasters, Section Foremen and Construction Foremen

This book is presented in a very clear manner, which is at once simple, thorough and practical.

The contents include chapters on General Turn-outs; Stub and Split Switches; Analysis of Curves; and a large number of tables for the quick and correct construction of any switch.

Cloth, 174 pages; 4½x6¼ inches. Price, $1.00, net postpaid.

Maintenance of Way Standards, by F. A. Smith, M. E., C. E. - Price, $1.50
Standard Turn Outs on American Railroads, by F. A. Smith - Price, 1.00
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Descriptive Circulars upon Application

The Myron C. Clark Publishing Co.
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Interlocking Switch Stand

You make a careful inspection of switches to see that they hold the points up to the rail. The Foster Interlocking Switch Stand guarantees the points to be up to the rail and secured with two separate connections from the points to the ties. The lever will not enter the latch until the point is up to the rail and bolt locked. If there is lost motion in the connections or an obstruction between the point and the rail the lever cannot be forced down into the latch. With this stand the points must be kept adjusted within safe limits to be able to operate the stand.

Any track device which is not operated by experienced men must be simple and positive. One throw of one lever parallel with the track performs all operations with the Foster Interlocking Switch Stand. This stand guarantees safe switches between times of inspections and is easy and simple to operate. It provides additional safety and does not complicate the operation of your switches. Your inspection is to see that the switches are in good order and this stand is made to keep them in good order.

One throw of ONE LEVER operates Switch, Interlock, Signals.

Foster Interlocking Switch Stands have been tested in service and do all that is claimed for them.

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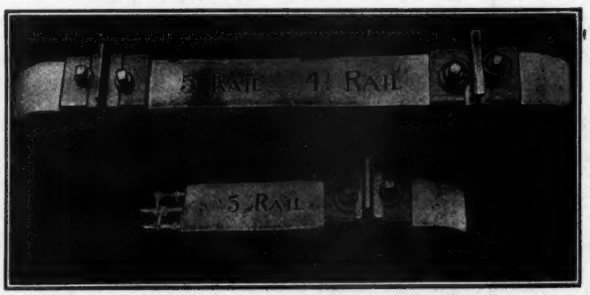
515 W. First Ave., Columbus, Ohio

The Universal Concrete Tie

Note carefully the details of the spiking device and the peculiar "V" shape of the base of the Tie at the center, which insures an absolutely perfect alignment, obviates spreading of the rails, or the slewing of the track. The heavy hardwood cushions preserve the rolling stock as well as the tie; last for six to fifteen years, and are then almost instantly removed by the loosening of the screw spikes by one man.

The Percival Patents

In use under various Trunk Line Railways for five and six years past.



The above cut illustrates the Universal Concrete Tie.

For further facts and full evidence, address the

UNIVERSAL CONCRETE TIE COMPANY

1408-9 Whitney-Central Bldg. NEW ORLEANS, LA.

Trains are running sixty miles an hour over these ties, and have been so running for more than five years, yet they have had no repairs, realigning or even tightening of the spiking devices.

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The best tie for terminals, because it is permanent.

The best tie for yards, because it is fire proof, rust proof, and will hold rails true to gauge.

The best tie for main lines and heavy traffic, because it is absolutely dependable under all conditions, as we can show in roads using them.

NON-CORROSIVE wooden water pipe is manufactured by The Michigan Pipe Co.

The pipe is steel banded, as shown. The steel bands are protected by a coat of imperishable asphaltum cement. The pipe is strong as steel with the resiliency of wood.

Some advantages of "Michigan Wood and Steel Pipe:

Will not corrode. — Protects water from freezing. — Less friction than metal pipe. — Withstands vibration without loosening the joints. — Withstands water hammer without bursting. — Withstands Hydraulic Pressure of 200 lbs. per sq. inch.

Many other advantages explained in our catalogue—write for it.

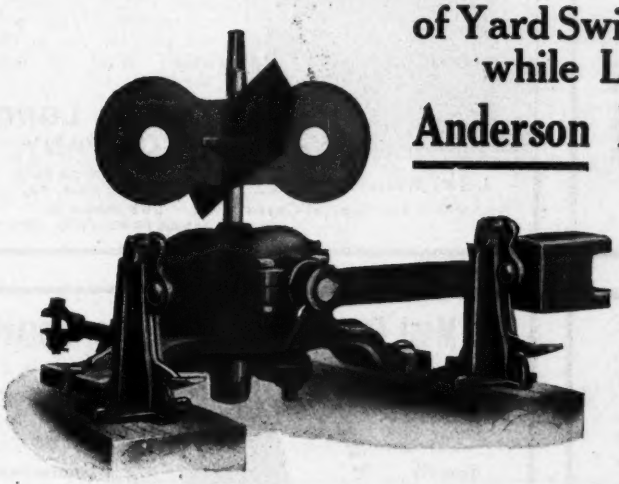
This pipe **lasts indefinitely,** and can be made as **strong as desired.**

THE MICHIGAN PIPE CO., Bay City, Michigan

16 2/3 CENTS Maximum Maintenance Cost

of Yard Switches that are Run Through while Latched if you use the

Anderson Economy Switch Stand



This stand for yard switches, is provided with a special 3 way crank arm made of malleable iron. This 3 way crank arm is designed that when switch is run through, one of the arms to which the switch is connected will shear off, without damage, to any part of the switch mechanism.

The switch can be quickly placed in order by connecting the rod to one of the other arms. When the three arms are destroyed a new three way crank can be applied. These are furnished at 50 cents each. This feature is not new.

Over 30,000 Economy switch stands with this special 3 way crank, in service on many railroads.

Nonbreakable cranks are furnished for main line switches.

Full Details and Description of This Switch Stand in Our Catalogue. Write for It

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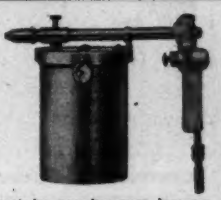

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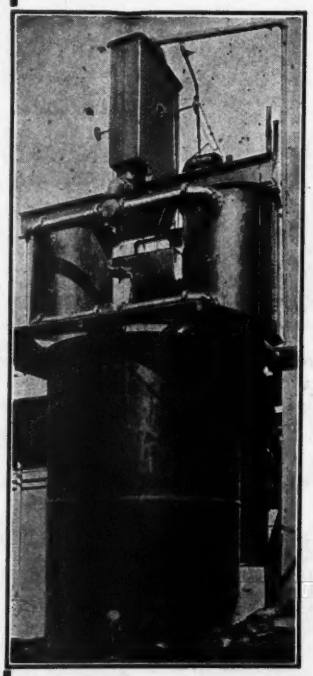

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Every locomotive water supply station—getting its water from a different source—is a separate water purifying problem for the railroad man.

Foaming troubles are a universal complaint, and it is only by our unusually long experience of 50 years in the water purifying business and a special study of conditions in alkaline water districts that

LORD'S WATER PURIFYING CHEMICALS

have attained such a remarkable success.

They completely remove any existing scale and prevent its formation.

Tell us your conditions, and let us suggest a remedy. This will not obligate you in the least. Write us now about it.

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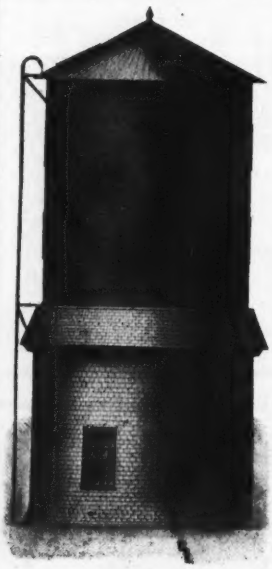

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Range and Capacities of the different types are as follows:

	If Not Over	Capacity.	Throat Opening	Wt. Each
Type M for rail 12 - 45 lbs.	3½ inches high	20 Ton Locomotive	2 ins.	30
Type C for rail up to 65 lbs.	4½ inches high	30 Ton Locomotive	2½ ins.	60
Type B for rail up to 80 lbs.	5 inches high	50 Ton Locomotive	3½ ins.	110
Type A for rail up to 100 lbs.	5½ inches high	80 Ton Locomotive	3½ ins.	145
Type Z for rail up to 100 lbs.	6 inches high	100 Ton Locomotive	3½ ins.	185

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GRAVER PRODUCTS

FAVORABLY KNOWN FOR

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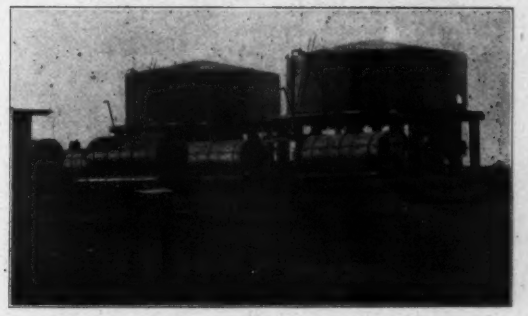

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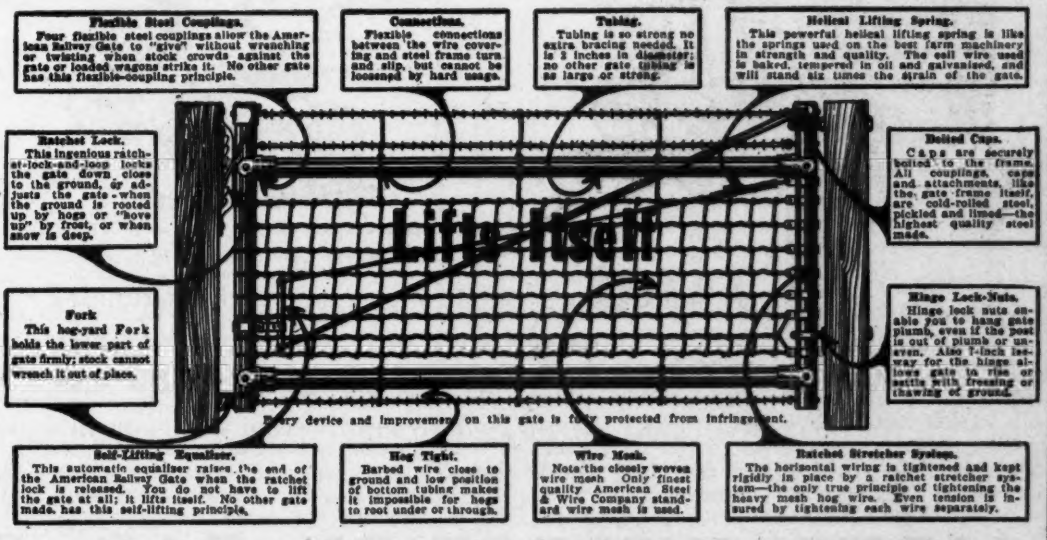
Maintenance vs First Cost — For One Gate Opening

The relation of maintenance to first cost as effecting final net returns from a given investment, is frequently not fully appreciated by railway officials who continue to use wooden gates. Why specify and buy four or five cheap gates to fill the same opening in ten years' time, spending the railroad's money (at least $25.00)—also claims paid for "stock killed"—also "continual repairs" on a gate that will not keep stock off the right-of-way, when for one-fourth of the amount railroads can purchase an American Self-Lifting High Carbon Steel Galvanized Gate that will settle the cost and expense for that opening forever? Note advantages of American Railway Gates.

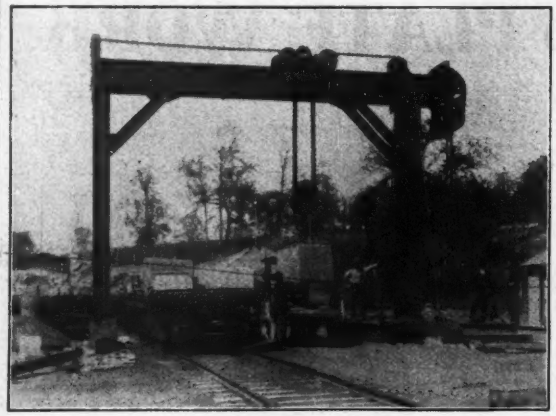
"Drags up Never Down." Horse High. Bull Proof. Fool Proof and Hog Tight. Painted or Galvanized.


Flexible Steel Couplings.
Four flexible steel couplings allow the American Railway Gate to "give" without wrenching or twisting when stock crowds against the gate or loaded wagons strike it. No other gate has this flexible-coupling principle.
Connections.
Flexible connections between the wire covering and steel frame turn and slip, but cannot be loosened by hard usage.
Tubing.
Tubing is so strong no extra bracing needed. It is 2 inches in diameter; no other gate tubing is as large or strong.
Helical Lifting Spring.
This powerful helical lifting spring is like the springs used on the best farm machinery in strength and quality. The coil wire used is baked, tempered in oil and galvanized, and will stand six times the strain of the gate.
Ratchet Lock.
This ingenious ratchet-lock-and-loop locks the gate down close to the ground, or adjusts the gate when the ground is rooted up by hogs or "hove up" by frost, or when snow is deep.
Lifts Itself
Bolted Caps.
Caps are securely bolted to the frame. All couplings, cams and attachments, like the gate frame itself, are cold-rolled steel, pickled and limed—the highest quality steel made.
Fork
This hog-yard Fork holds the lower part of gate firmly; stock cannot wrench it out of place.
Hinge Lock-Nuts.
Hinge lock nuts enable you to hang gate plumb, even if the post is out of plumb or uneven. Also T-inch leeway for the hinge allows gate to rise or settle with freezing or thawing of ground.
Every device and improvement on this gate is fully protected from infringement.
Self-Lifting Equalizer.
This automatic equalizer raises the end of the American Railway Gate when the ratchet lock is released. You do not have to lift the gate at all; it lifts itself. No other gate made has this self-lifting principle.
Hog Tight.
Barbed wire close to ground and low position of bottom tubing makes it impossible for hogs to root under or through.
Wire Mesh.
Note the closely woven wire mesh. Only finest quality American Steel & Wire Company standard wire mesh is used.
Ratchet Stretcher System.
The horizontal wiring is tightened and kept rigidly in place by a ratchet stretcher system—the only true principle of tightening the heavy mesh hog wire. Even tension is insured by tightening each wire separately.

THE GATE THE FARMER WILL "KEEP CLOSED"—SO EASY TO OPERATE. WE CONTRACT AND SHIP EVERYWHERE. WRITE US FOR PRICES, CARLOAD OR LESS.

American Farm Gate Company, R. R. Dept., Kansas City, Mo., U. S. A.

H. L. GOODWIN, Vice-President and General Manager



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is an inexpensive and durable machine for handling all heavy loads from car or wagon with just one or two men. Being equipped with safety appliances, it practically eliminates all danger to the men.

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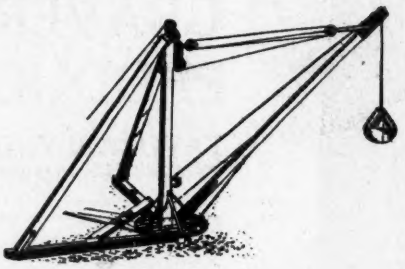

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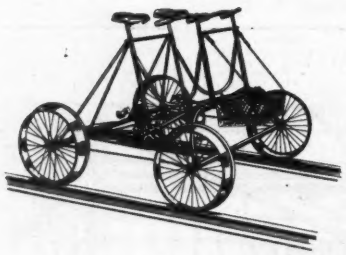

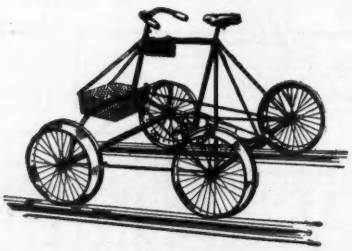

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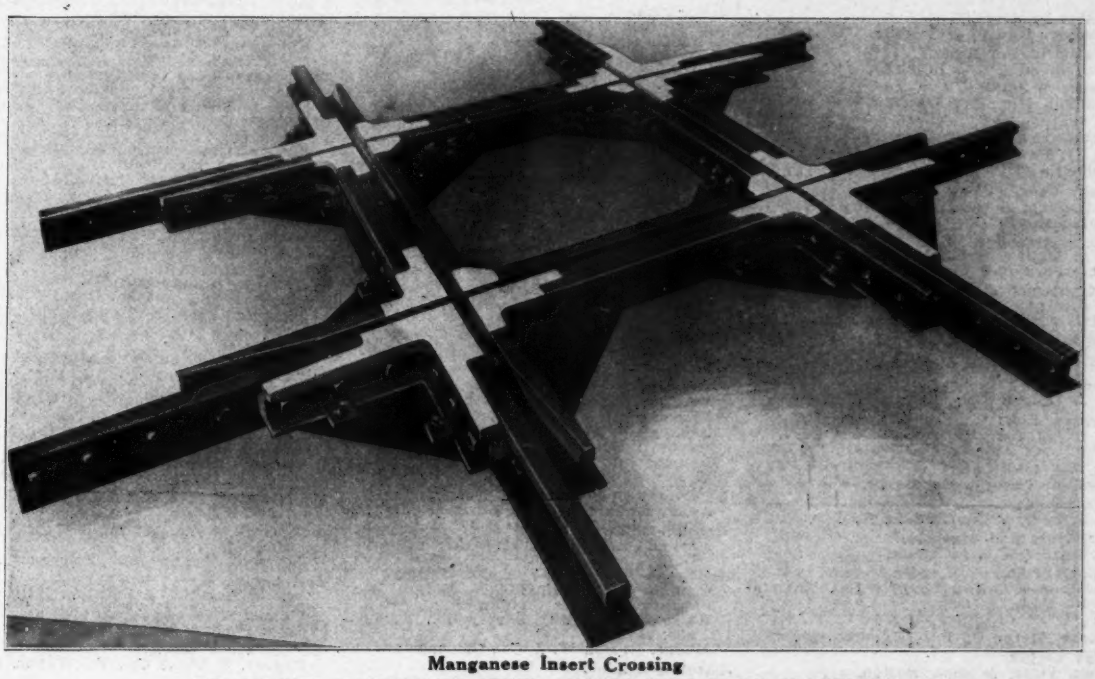

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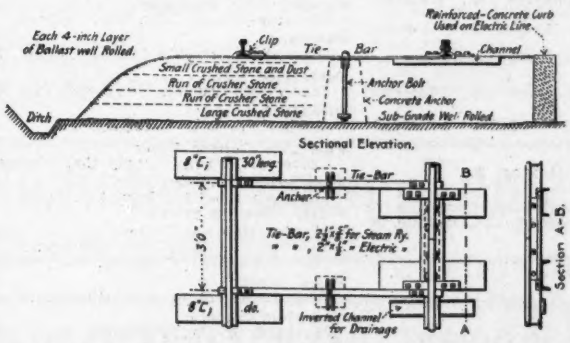
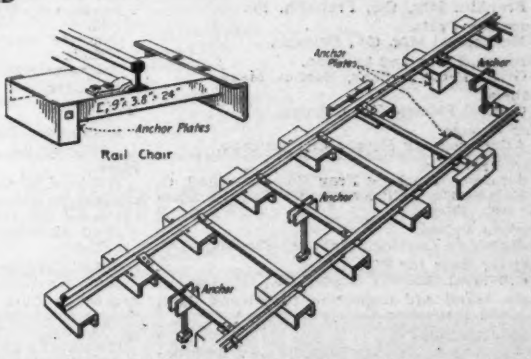


Track Construction with a watertight bed of rolled stone ballast.



Track Construction for very heavy traffic, used in connection with heavily rolled bed of broken stone.

A reinforced compacted monolithic bed or permanent way is a support for the rails and rail chairs. The chairs may be considered under the head of tie plates. My bed represents both the ballast and wooden ties combined. A bed constructed on my plan will answer every condition required of both, and more too. The alignment is permanently maintained, as well as surface and gage. It will admit of the use of anti-creeper appliances. There is a scrapping value in the steel after being used. The bed will not settle out of sight in the soft ground and be lost. It is practically water-tight, and has a tendency to prevent the settlement of embankments. It can be constructed to carry wheel loads of 30,000 lbs. each at maximum speeds.

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Universal Railway Supply Co., Chicago.

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Michigan Pipe Co., Bay City, Mich.

Plate. (See Tie Plates.)

Pole Line Material.
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Poles, Steel.
Electric Ry. Equip. Co., Cincinnati.

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Hubbard & Co., Pittsburg, Pa.

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Kalamazoo Railway Supply Co., Kalamazoo, Mich.

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Kalamazoo Railway Supply Co., Kalamazoo, Mich.

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Atlas Railway Supply Co., Chicago.
Cincinnati Frog & Switch Co., Cincinnati, O.
Indianapolis Switch & Frog Co., Springfield, O.
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Indianapolis Switch & Frog Co., Springfield, O.
Industrial Supply & Equipment Co., Philadelphia.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
Mudge, Burton W., & Co., Chicago.
Rail Joint Co., New York.
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Weir Frog Co., Cincinnati.

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Johnson Wrecking Frog Co., Cleveland, O.

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Franklin Mfg. Co., Franklin, Pa.

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Concrete Form & Engine Co., Detroit, Mich.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.
Mudge, Burton W. & Co., Chicago, Ill.

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Franklin Mfg. Co., Franklin, Pa.

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Gray, Peter, & Sons, Boston.

Shingles, Asbestos.
Franklin Mfg. Co., Franklin, Pa.

Shovel Handles.
Wyoming Shovel Wks., Wyoming, Pa.

Shovels, Spades and Scoops.
Hubbard & Co., Pittsburg, Pa.
Wyoming Shovel Wks., Wyoming, Pa.

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Gray, Peter, & Sons, Boston.

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Franklin Mfg. Co., Franklin, Pa.

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Dilworth Porter & Co., Pittsburg.
Hart Steel Co., Elyria, O.

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Michigan Pipe Co., Bay City, Mich.

Steel Forms.
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Marsh Co., Chicago.

Steel Plate Work.
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Marsh Co., Chicago.

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Seelig, R., & Son, Chicago.

Switch Lanterns.
Gray, Peter, & Sons, Boston.

Switch Rods.
Weir Frog Co., Cincinnati, O.
Ramapo Iron Works, Hillburn, N. Y.

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Atlas Railway Supply Co., Chicago.
Cincinnati Frog & Switch Co., Cincinnati.
Frog, Switch & Mfg. Co., Carlisle, Pa.
Indianapolis Switch & Frog Co., Springfield, O.
Ramapo Iron Works, Hillburn, N. Y.
Weir Frog Co., Cincinnati.

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Tank Cars.
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Wm. Graver Tank Works, E. Chicago, Ind.
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Track Drills.
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Track Laying Cars.
Kalamazoo Railway Supply Co., Kalamazoo, Mich.

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Ramapo Iron Works, Hillburn, N. Y.
Weir Frog Co., Cincinnati.

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Wyoming Shovel Works, Wyoming, Pa.

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Philadelphia Turntable Co., Philadelphia.

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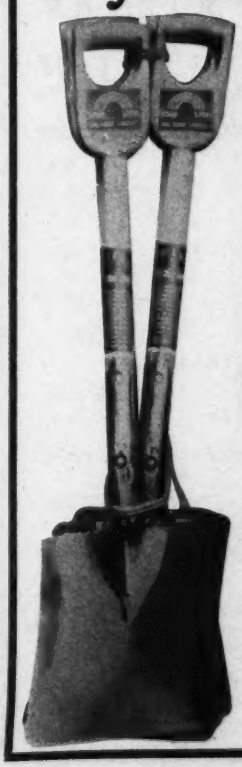

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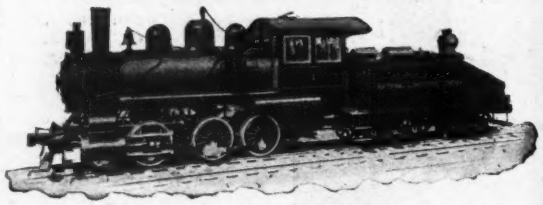

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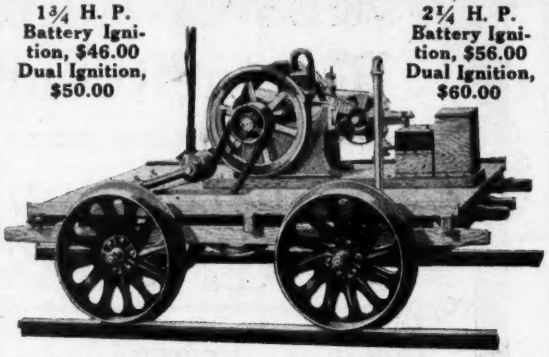

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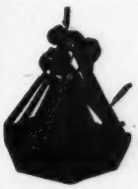

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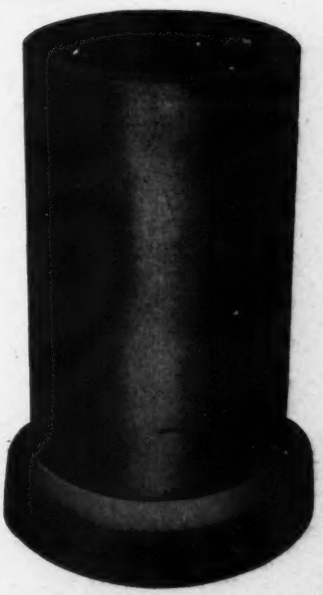

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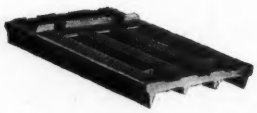

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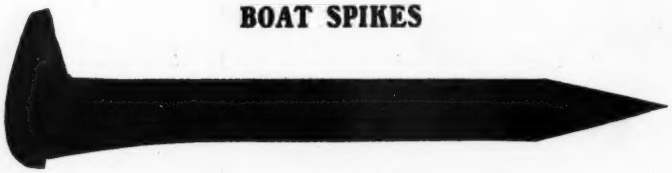

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